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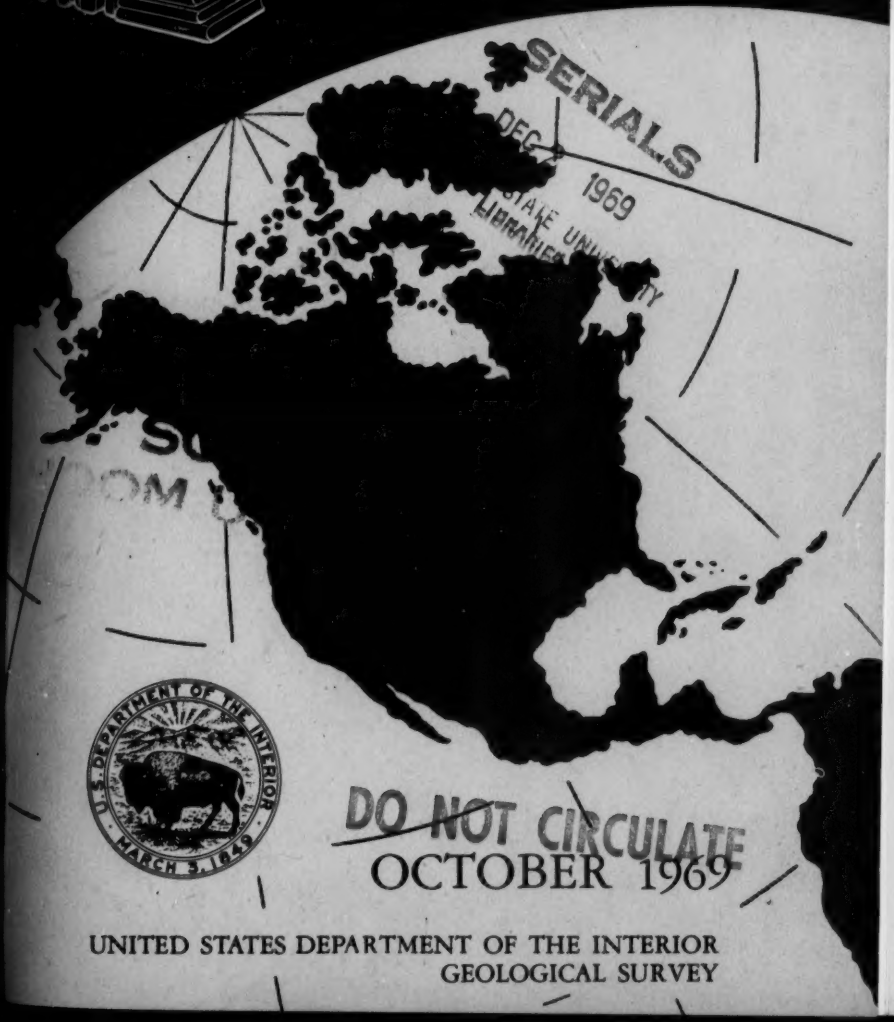

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UNITED STATES DEPARTMENT OF THE INTERIOR
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ABSTRACTS OF NORTH AMERICAN GEOLOGY

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ABSTRACTS OF NORTH AMERICAN GEOLOGY

INTRODUCTION

Abstracts of North American Geology contains abstracts of technical papers and books and also citations of maps on the geology of North America including Greenland, the West Indies, as well as the State of Hawaii, Guam, and other island possessions of the United States. Articles of a general nature by North American authors are cited even though published in foreign journals but those by foreign authors are included only if they appear in North American journals. Abstracts are prepared only of material that is believed to be generally available. Ordinarily abstracts are not published of material with small circulation (such as dissertations, open-file reports of memorandums) or of other papers presented orally at meetings.

The Abstracts is an additional reference tool but does not replace the Bibliography of North American Geology, which has been published by the Geological Survey since 1887. Twelve monthly issues of Abstracts of North American Geology are published each year. The Bibliography includes citations and subject index for a calendar year.

The numbers assigned to the abstracts in this publication are for reference in using the index; they are not order numbers. Publications cited here in abstract form are available in most geological libraries or through interlibrary loan.

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A list of journals commonly cited in Abstracts of North American Geology may be obtained by writing to the U.S. Geological Survey, Washington, D. C. 20242. Serial publications cited for the first time are as follows:

British Speleol. Assoc. Proc.—Proceedings of the British Speological Association. Settle, Yorkshire, England.

West Virginia Geol. and Econ. Survey River Basin Bull.—West Virginia Geological and Economic Survey River Basin Bulletin. Morgantown, W. Va.

The abstracts in this issue were prepared by Georgianna D. Conant, Howard R. Cramer, Katherine A. Friberg, Virginia M. Jussen, Elisabeth S. Loud, Mildred C. Mead, E. A. Merewether, Virginia S. Neuschel, E. G. Sable, Marie Siegrist, and Dorothy B. Vitaliano.

ABSTRACTS

01916 **Adamek, James Conrad.** Lift and drag forces on a cube on a boundary in a finite, three-dimensional flow field with free-surface effects [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2894B, 1969.

01690 **Ahr, Wayne M.** Paleoenvironment, algal structures, and fossil algae in Upper Cambrian of central Texas [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 703, 1969.

01962 **Ahrens, L. H.** The composition of stony meteorites—General introduction: Earth and Planetary Sci. Letters, v. 5, no. 6, p. 382, 1969.

This is an introduction to a symposium concerning the determination of 12 elements in 48 chondrites and 6 achondrites. In work of this type four requirements should be satisfied as far as possible: (1) relatively large numbers of specimens of each meteorite should be analyzed, (2) the accuracy of the determination of each element should be high, (3) relatively large samples should be available for study (5-10 g), and (4) each element should be determined in the same sample. The three papers (Von Michaelis and other(s) and Ahrens and Von Michaelis) are cited separately.—HRC

01963 **Ahrens, L. H.; VonMichaelis, H.** The composition of stony meteorites—[Pt.] 3, Some inter-element relationships: Earth and Planetary Sci. Letters, v. 5, no. 6, p. 395-400, illus., tables, 1969.

The relationship between Ca and Al in chondrites and basaltic achondrites has been examined and is shown to be remarkably close. According to our data, Ti, Zr, and Sr show a like relationship, which however, may not be so well-developed. The available data in the literature show that Sc, Y, rare earths, Ba, U, and Th have similar trends. All the above elements have been classed in the Ca-Al group. Their behavior is important when considering theories of origin of the meteorites and of other members of the solar system.—Authors' abstract

Ahrens, L. H. *See* VonMichaelis, H. 01964

Ahrens, L. H. *See* VonMichaelis, H. 02021

07402 **Ahrens, Thomas J.; Rosenberg, J. Thomas.** Shock metamorphism—Experiments on quartz and plagioclase, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 59-81, illus., tables, 1968.

Anomalously large compressions obtained at shock pressures about 100 kb in Hugoniot experiments on polycrystalline quartz and plagioclase of andesine composition are probably due to partial transformation to stishovite and a high-pressure phase of plagioclase whose structure is similar to rutile, respectively. Release adiabat measurements gave data indicating that quartz is converted to a mixture of quartz and coesite, or quartz and stishovite, at pressures between 111-144 kb, some of which is retained upon pressure release. More stishovite is produced at higher shock pressures, which upon pressure release apparently reverts to a lower density material at about 50 kb. Similar shock and release behavior patterns were obtained for plagioclase, but the high-pressure polymorph has not yet been identified; the lower density material probably represents maskelynite.—MS

07463 **Aitken, F. K.; Gold, D. P.** The structural state of potash feldspar—A possible criterion for meteorite impact?, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 519-530, illus., 1968.

Triclinicity values of K-feldspars from Precambrian granitic rocks of five structures of possible impact origin exhibited variations that are analyzed with reference to the possibility that they may represent a parameter diagnostic of impact metamorphism. The structural state of the feldspars apparently is not a sensitive indicator of shock metamorphism, but may serve as a parameter for defining zones in which considerable heat has been generated.—MS

01884 **Akright, Robert L.; Radtke, Arthur S.; Grimes, David J.** Minor elements as guides to gold in the Roberts Mountains Formation, Carlin gold mine, Eureka County, Nevada, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 49-66, illus., 1969.

Average element abundances in mineralized gold-bearing rocks of the Roberts Mountains Formation at the Carlin mine are given. In general the total abundance range for any given element is much greater in mineralized than in unmineralized rock. This distribution of metals is apparently a characteristic of disseminated-type gold deposits and may, together with argillic alteration, be a clue to mineralization in parts of the Roberts Mountains Formation. Traverses from the Vinini Formation, across the Roberts Mountain thrust fault to the Popovich Formation, and into the mineralized upper units of the Roberts Mountains Formation show that abundance levels of most minor elements are low in the Popovich Formation and that the Vinini Formation is characterized by a minor-element suite with erratic distribution and wide ranges in abundance.—KAF

01714 **Allen, P.** Lower Cretaceous sourcelands and the North Atlantic: Nature, v. 222, no. 5194, p. 657-658, illus., 1969.

K-Ar dating of detrital micas in Weald clays from Sussex and Surrey as Caledonian and Hercynian throws light on sources of North Atlantic Lower Cretaceous sediments. Following conventional drift theory, there was a unified Europe-Africa-America continental raft. If it were divided by the sea before Wealdian times (>135 m.y. ago) then the 'American-type' materials in Europe can be explained by suppositions which would hold whether division resulted from epicontinental transgression or continental rupture. If the latter, then the later the rupture the easier it is to explain geomorphic similarities between America and Europe-Africa lasting into Wealdian times. If division occurred during or soon after Wealdian times, assumptions concerning a derivation from crystallines now submerged beneath the Western Approaches can be avoided by postulating immediate rupture, giving rise to easterly drainage along a rift valley growing between America and Europe-Africa.—DBV

01825 **Allen, Robert C.; Gavish, Eliezer; Friedman, Gerald M.; Sanders, John E.** Aragonite-cemented sandstone from outer continental shelf of Delaware Bay—Submarine lithification mechanism yields product resembling beachrock: Jour. Sed. Petrology, v. 39, no. 1, p. 136-149, illus., tables, 1969.

A shelly sandstone containing a modern microfauna, recovered from 43 fms, has been cemented by cryptocrystalline aragonite and clear fibrous aragonite. Numerous organic borings, some algal, penetrate both cement and shells. The rock resembles beachrock, and intertidal formation. On the basis of the radiocarbon-controlled sea-level curve and on the supposition that the age of the shells indicates time of cementation, we conclude that cementation occurred on the sea floor under a cover of 75 m of seawater. A widespread occurrence of aragonite-cemented sandstone along the east coast of the United States suggests that the submerged littoral sand may have been cemented on a large scale, and was controlled by methane originating in adjacent tidal marshes, now submerged.—*from* Authors' abstract

01983 **Alvarez, U.; Menendez, L.** Seysmichnost' Kuby: Akad. Nauk SSSR Izv. Fizika Zemli 1969, no. 1, p. 74-78, illus., table, 1969.

Available data on the seismicity of Cuba is summarized systematically. Historical and macroseismic records, quoted from Sieberg, go back to 1826. Instrumental observations were not organized until 1964, when a seismic station was established near Santiago. A map shows the distribution of epicenters of shocks in Cuba and vicinity for the period 1910-66, compiled from various American publications.—DBV

Amsbury, D. L. *See* Stricklin, F. L., Jr. 01596

01723 **Anders, Edward; Heymann, Dieter.** Elements 112 to 119—Were they present in meteorites?: Science, v. 164, no. 3881, p. 821-823, illus., 1969.

Chondrites contain a small fission xenon component of unexplained origin. Evidence on the geochemical behavior of this component suggests that it was not derived from an actinide element (Z=89 to 103), or from a transition metal between Z=104 and 111, but from a more volatile progenitor. The most likely candidates are the superheavy elements between Z=112 and 119, whose lighter congeners (mercury, tellurium, lead, and the like) are known to be strongly fractionated in meteorites.—Authors' abstract

Anderson, Don L. *See* Lagus, Peter L. 07400

01850 **Andrew, Philip J.** Robert Emerson Bonar (1910-1969): Am. Assoc. Petroleum Geologists Bull., v. 53, no. 4, p. 1012, portrait, 1969.

Aparicio, P. *See* James, D. E. 01966

01691 **Armstrong, Augustus K.; Dutro, J. T.** Carbonate facies and coral zonation, Mississippian, Kogruk Formation, Lisburne Group, DeLong Mountains, Brooks Range, northwestern Alaska [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 704, 1969.

Arnal, Robert E. *See* Bandy, Orville L. 01763

07395 **Arnold, Chester A.** The proper designations of the foliage and stems of the Cordaitales: Phytomorphology, v. 17, nos. 1-4, p. 346-350, 1967 (1968).

The Cordaitales is a group of Paleozoic gymnosperms that makes its initial appearance in the Eur-American flora during Early Pennsylvanian. *Cordaites* Unger is an organ genus for detached foliage of the Cordaitaceae. It is proposed that both *Cordaites* and *Mesoxylon* Scott and Maslen be abandoned as organ genera for structurally preserved cordaitean stems, and that *Cordaioxylon* Grand'Eury ex Felix be adopted instead. *Dadoxylon* is suitable only for secondary wood, and should not be used for stems that contain other tissues having distinctive characters.—KAF

Arnold, R. W. *See* Protz, R. 07420

07436 **Arnold, R. W.** Pedological significance of lithologic discontinuities [with French and German summ.], *in* Internat. Cong. Soil Sci., 9th, Adelaide, Australia, 1968, Trans., V. 4: New York, American Elsevier Publishing Co., p. 595-603, tables, 1968.

Satisfactory pedogenic interpretations are often dependent on one's ability to recognize a lithologic discontinuity. Concepts of soil development based on the assumption of homogeneous parent material commonly overestimate the amount of change required for profile differentiation. Data from a well-drained pedon are used to demonstrate differences in the amount of change according to presence and location of a lithologic discontinuity. Knowledge of geomorphic events and their ages in the sequence of landscape evolution is essential to an adequate explanation of the rates of soil forming processes, for without datable events it is possible to calculate a variety of process rates. Most soils can be classified on the basis of quantitative morphology, but a suitable explanation of pedogenesis requires the recognition of lithologic discontinuities and an understanding of their age relationships.—Author's summary

01737 **Asmussen, Loris E.** Quaternary sediment distribution above the Hazelhurst shoreline [abs.]: Georgia Acad. Sci. Bull., v. 27, no. 2, p. 87-88, 1969.

01738 **Austin, Roger S.** A stratigraphic section in the metamorphic Little River Group in east central Georgia [abs.]: Georgia Acad. Sci. Bull., v. 27, no. 2, p. 88, 1969.

07466 **Axon, H. J.; Boustead, J.; Yardley, E. D.** The mechanical and thermal alteration of iron meteorite structures, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 585-599, illus., 1968.

Recent electron microprobe investigations of the diffusion profiles of nickel in selected octahedrites have enabled estimates to be made of the cooling rates at which the Widmanstätten structures originally formed. These calculated rates require that the parent meteorite bodies be very much larger than known meteorite falls, and it is thus necessary to assume that fragmentation of the parent bodies occurred after the Widmanstätten pattern had formed. The object of the present paper is to outline some of the mechanical and thermal alterations which iron meteorites have undergone, either at the time of primary fragmentation, or at some later stage. Metallographic effects which may be identified include shock-hardening of kamacite, solid-state recrystallization of kamacite, alteration of plessite and phosphides, production of martensitic structures, and complete remelting. Analogous effects also occur in the sulphide phases.—Authors' abstract

Baadsgaard, H. *See* Green, D. C. 07481

Bagby, Robert. *See* Mitchell, Jeffrey Leonard. 01744

01952 **Bahjat, Dhari Saaid.** Decoupling and source function for explosions in a three-dimensional model [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3367B, 1969.

01692 **Baker, Donald R.; Ferguson, William S.; Claypool, George E.** Organic geochemistry and petroleum distribution on Cherokee platform, Kansas and Oklahoma [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 704-705, 1969.

01904 **Baldar, Nouri Amin.** Occurrence and formation of soil zeolites [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2707B-2708B, 1969.

01693 **Ball, Stanton M.** Importance of storm activity in depositional history of Westphalia (Pennsylvanian) Limestone Member of northern mid-continent exposures [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 705, 1969.

Balsley, John. *See* Stokes, William Lee. 07355

Bambach, Richard K. *See* Ziegler, Alfred M. 07394

01694 **Bandy, Orville L.; Morin, Ronald W.; Wright, Ramil.** Identification of *Catapsydrax stainforthi* zone in upper part of lower Saucesian Stage, California [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 705, 1969.

01763 **Bandy, Orville L.; Arnal, Robert E.** Middle Tertiary basin development, San Joaquin Valley, California: Geol. Soc. America Bull., v. 80, no. 5, p. 783-819, illus., tables, 1969.

Biofacies studies of well samples from the southern part of the San Joaquin Valley made possible the recognition of 13 paleobathymetric zones between depths of 0 and more than 6,000 feet. Paleobathymetric maps indicate that the basin was deepest (abyssal depths) in Oligocene and early Miocene time, and shallowed to neritic depths in latest Miocene and Pliocene time; these maps also indicate that a connection with oceanic waters to the west occurred consistently at the southwestern corner of the basin across the San Andreas fault, and frequency maps of planktonic foraminifera indicate that the principal current moved counter clockwise. Sedimentation exceeded subsidence and more than 5,000 cubic miles of strata represent the sediments deposited during the middle Tertiary stages.—HCW

01982 **Banks, H. P.; Davis, M. R.** *Crenaticaulis*, a new genus of Devonian plants allied to *Zosterphyllum*, and its bearing on the classification of early land plants: Am. Jour. Botany, v. 56, no. 4, p. 436-449, illus., tables, 1969.

The name *Crenaticaulis verruculosus* is proposed for slender, pseudomonopodially and dichotomously branching plants that bore opposite to sub-opposite sporangia along the stem and two rows of prominent multicellular teeth on opposite sides of the terete axis. No spores were found. Sections revealed a cortex consisting of four to six rows of thick-walled cells and a xylem strand. Tracheids were chiefly scalariform. It is suggested that the so-called axillary tubercles, known in several plants of Devonian age, were scars of rhizophores like those in the modern genus *Selaginella*. This plant is referred to the subdivision Zosterophyllophytina.—*from* Authors' abstract

01872 **Barakso, J. J.** Soil and plant relationships to bedrock at some mineralized areas in British Columbia [abs.], *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 507-508, 1969.

01955 **Barfield, Billy Joe.** Studies of turbulence in shallow sediment laden flow with superimposed rainfall [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3382B-3383B, 1969.

01939 **Barnard, Frederick L.** Structural geology of the Sierra de los Cucapas, northeastern Baja California, Mexico, and Imperial County, California [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3360B, 1969.

Barnes, Sarah S. *See* Echols, Ronald J. 01668

01697 **Barnes, William M.** Yates (Permian) carbonate reservoir, Winkler County, Texas [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 705, 1969.

01911 **Barr, David John.** Use of side-looking airborne radar imagery for engineering soils studies [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2864B-2865B, 1969.

Barron, K. *See* Norris, D. K. 01758

01696 **Barrow, Thomas D.** Summary of offshore exploration and production [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 705-706, 1969.

01940 **Bartleson, Bruce Landon.** Stratigraphy and petrology of the Gothic Formation, Elk Mountains, Colorado [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3360B-3361B, 1969.

01698 **Bebout, Don G.; Coogan, A. H.; Maggio, Carlos M.** Golden Lane-Poza Rica trends, Mexico—An alternate interpretation [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 706, 1969.

01731 **Beck, Myrl E., Jr.; Lindsley, Nancy C.** Paleomagnetism of the Beaver Bay complex, Minnesota: Jour. Geophys. Research, v. 74, no. 8, p. 2002-2013, illus., tables, 1969.

Magnetic anisotropy caused by preferential alignment of inequant magnetite grains within the lamination appears to have deflected the direction of remanent magnetization of the Beaver Bay ferrogabbro by about 8.5°. When samples from the ferrogabbro are eliminated, the resulting paleomagnetic pole for the rest of the Beaver Bay complex falls at 27.5° N., 170.5° W., where it forms part of a distinct cluster of paleomagnetic poles for Keweenawan igneous rock units of negative (normal) polarity. Positively magnetized Keweenawan igneous rocks give paleomagnetic pole positions that are scattered over a considerable area to the northeast of the cluster of negative poles. Magnetic intensities vary markedly throughout the complex, probably in response to the ordinary processes of magmatic differentiation.—*from* Authors' abstract

Beerbower, J. R. *See* Bray, R. G. 01706

01695 **Beerbower, James R.; Jordan, Dianne.** Application of information theory to paleontologic problems—[Pt.] 1, Taxonomic diversity [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 706, 1969.

01833 **Behrens, E. William; Watson, Richard L.** Differential sorting of pelecypod valves in the swash zone: Jour. Sed. Petrology, v. 39, no. 1, p. 159-165, illus., tables, 1969.

Differential sorting of right and left valves of pelecypods was found to be common on Mustang and Padre Island beaches, Texas. Determination of stable orientations of valves in unidirectional flume currents enables one to predict their behavior on a beach washed by obliquely approaching waves. The valves become initially stable with respect to the oblique swash and then are sorted by the backwash. Further observations on the beach confirm that opposing valves behave as predicted. Sense of sorting is correlated to direction of wave approach and with direction of longshore drift. Interpretations of paleodrift directions from R-L sorting may be possible, but narrowness of the inter-tidal zone in which sorting takes place, and rapidity of resorting, plus uncertainties in hydrodynamic behavior of fossilized material, dictate extreme care in attempting analyses.—*from* Authors' abstract

07412 **Bell, Peter M.; Boyd, F. R.** Phase equilibrium data bearing on the pressure and temperature of shock metamorphism, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 43-50, illus., table, 1968.

In addition to coesite and stishovite, various other high-pressure mineral phases produced during phase equilibrium experiments carried out under static conditions may ultimately be found in shocked rocks. Growth and persistence of such phases under the transient conditions of shock metamorphism are probably controlled by reaction rate and rapidity of quench. Temperature and shearing stress may exert certain controls. Data on glasses with high indices of refraction indicate dependence of the index on pressure and the possibility that the shocked material may have melted, but they are not sufficiently abundant to warrant quantitative applications.—MS

01739 **Bennett, Jackson.** Soil erosion, its effect on morphogenesis of the landscape, Greene County, Georgia [abs.]: Georgia Acad. Sci. Bull., v. 27, no. 2, p. 88-89, 1969.

01699 **Berger, Wolfgang H.** Kummerform Foraminifera as clues to oceanic environments [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 706, 1969.

01879 **Bergh, Hugh W.** Paleomagnetism of the Stillwater complex, Montana [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2946B-2947B, 1969.

02005 **Bernat, Michel; Goldberg, Edward D.** Thorium isotopes in the marine environment: Earth and Planetary Sci. Letters, v. 5, no. 5, p. 308-312, illus., tables, 1969.

Analyses of thorium isotopes isolated from fractions of a North Pacific core, representing authigenic and detrital minerals, indicated that there were movements of Ra-228 within the sedimentary column, that the thorium comes to the deposit primarily from sea water, that there is no evidence for the migration of thorium isotopes within the sedimentary column, and that there is a continued growth of phillipsite at depths in the column. Finally, there appeared to be a preferred accomodation of Pa-231 and/or Ac-227 in the phillipsite, the authigenic zeolite, relative to the detrital minerals. The high values of Th-228/Th-232 ratios in sea water may be influenced by the contribution of Th-228 arising from Ra-228 migrations through the water-sediment interface.—Authors' abstract

01700 **Berryhill, Henry L., Jr.; Dickinson, Kendell A.; Holmes, Charles W.** Criteria for recognizing ancient barrier coastlines [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 706-707, 1969.

01732 **Bhathal, R. S.; Stacey, F. D.** Frequency independence of low-field magnetic susceptibility of rocks: Jour. Geophys. Research, v. 74, no. 8, p. 2025-2027, table, 1969.

A mutual inductance bridge with very low stray capacities has been used to seek, unsuccessfully, a frequency variation in the magnetic susceptibilities of rocks and dispersed powdered magnetite in low fields. The upper limit of susceptibility variation for the more strongly magnetic samples is 0.1 percent over the range 100 to 1000 Hz, smaller by a factor 10 than an estimate based on the theory of magnetic viscosity. Susceptibility anisotropy due to domain alignment is also independent of frequency.—Authors' abstract

Bidwell, L. E. *See* Winter, T. C. 01961

07437 **Bidwell, O. W.; Gier, D. A.; Cipra, J. E.** Ferromanganese pedotubules on roots of *Bromus inermis* and *Andropogon gerardii* [with French and German summ.], *in* Internat. Cong. Soil Sci., 9th, Adelaide, Australia, 1968, Trans., V. 4: New York, American Elsevier Publishing Co., p. 683-692, illus., table, 1968.

Dark red iron-cemented pedotubules (iron-manganese concretions, rhizoconcretions, or pipestems), extensive during dry months on roots of bromegrass in light brownish gray silty clay loam loess in northeast Kansas, disappear when soil is saturated during the spring. Then soft soil granules the same color as soil matrix replace the hard red concretions. Similar concretions on roots of bluestem grass in olive gray loessial soils of north-central Kansas, with 5 inches less annual precipitation, soften to same consistency as adjacent soil, but remain yellowish-red. Pedotubule length varies from 10 to 15 mm, diameter, from 3 to 15 mm. Some appear uniformly composed; many are concentrically banded, with manganese concentrated near the plant root and iron at the concretion's edge. They contain up to 15 percent Fe and 2 percent Mn compared with 1.5 percent Fe and 0.016 percent Mn in adjacent soil.—*from* Authors' summary

01701 **Bigarella, João Jose.** Dune sediments—Characteristics, recognition and importance [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 707, 1969.

Bikova, A. V. *See* Perrault, Guy. 02010

Billings, Marland P. *See* Tierney, F. Lyle. 07390

Bisque, R. E. *See* Stevens, D. N. 01868

Bloom, D. N. *See* Stevens, D. N. 01868

01863 **Bloom, Harold.** The education of the exploration geochemist—A panel discussion, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 27-47, 1969.

Representatives from government, geological surveys, the mining industry, and the universities present their views on the education of the exploration geochemist. The exploration geochemist should be trained first in geology, especially in the details of mineral and petroleum deposits. On this foundation should be superimposed a thorough knowledge of the fundamentals of geochemistry, geochemical prospecting, analytical chemistry and statistics.—KAF

Bodkin, J. B. *See* Medlin, J. H. 01743

01725 **Bodvarsson, Gunnar.** On the temperature of water flowing through fractures: Jour. Geophys. Research, v. 74, no. 8, p. 1987-1992, 1969.

Fluids flowing through fractures in impermeable rock exchange heat with the surrounding medium. The fundamental equations governing the transport of heat in such systems are given. Solutions are derived for the case of constant mass flow and the fluid entering the fractures with a temperature that is a sinusoidal function of time. The rock is assumed to be a homogeneous and isotropic conductor. Approximate solutions are derived for the case in which the temperature at the intake is an arbitrary function of time. The case involving weak oscillations in the mass flow is treated on the basis of a perturbation method. Finally, some of the solutions derived are extended to the case of the laminated solid where the fluid flows between the laminas.—Author's abstract

02018 **Bogard, D. D.; Burnett, D. S.; Wasserburg, G. J.** Cosmogenic rare gases and the ^{40}K-^{40}Ar age of the Kodaikanal iron meteorite: Earth and Planetary Sci. Letters, v. 5, no. 5, p. 273-281, illus., tables, 1969.

Measurements have been made of the cosmogenic He, Ne, and Ar in the metal phase and of the K-Ar ages of two glass inclusions in the Kodaikanal iron meteorite. The small amounts of cosmogenic rare gas are best interpreted as due to a low cosmic ray exposure age. From empirical production rates, ages of 12, 13, and 15 m.y. were obtained from the He-3, Ne-21, and Ar-38 concentrations, respectively. The He-3/Ne-21, He-3/He-4 and He-4/Ar-38 ratios are all consistent with low shielding during the exposure. The feldspar and glass have approximately equal K-Ar ages of 3.5 ± 0.1 and $3.3 \pm 0.1 \times 10^9$ yr respectively. These results place constraints on possible origins for the glass and feldspar.—Authors' abstract

01907 **Bohrer, Vorsila Laurene.** Paleoecology of an archaeological site near Snowflake, Arizona [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2768B, 1969.

01740 **Bond, T. A.** Depositional environments based on palynomorph assemblages [abs.]: Georgia Acad. Sci. Bull., v. 27, no. 2, p. 89, 1969.

07368 **Bond, T. A.** Permian palynological assemblage from the Wellington Formation, Kay County, Oklahoma: Pollen et Spores, v. 10, no. 2, p. 385-393, illus., 1968.

The palynological assemblage recovered from the Wellington Formation in Kay County, Oklahoma, includes 21 species of spore and pollen grains assigned to 17 genera. The Wellington Shale deposit in which the palynomorphs are preserved accumulated as a shallow-water marine sediment. Saccate forms comprise approximately 90 percent of the assemblage and are interpreted as being derived from an upland flora of close proximity to the deposition site. A minor, poorly preserved trilete spore assemblage indicates the lack of a well developed mesic lowland flora. Comparison to other Wellington Formation palynological assemblages shows this to be similar to the Kansas locality.—KAF

01908 **Boneham, Roger Frederick.** Palynology of three Tertiary coal basins in south-central British Columbia [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2769B, 1969.

02006 **Bottinga, Y.** Carbon isotope fractionation between graphite, diamond, and carbon dioxide: Earth and Planetary Sci. Letters, v. 5, no. 5, p. 301-307, illus., tables, 1969.

Carbon isotope fractionation factors for C-13 exchange between graphite, diamond, and carbon dioxide are calculated and tabulated for various temperatures between 0° and 1000°C. Lattice dynamics and the root sampling method were used to calculate the needed reduced partition function ratios for graphite and diamond. Approximate ways for doing the calculation and the geochemical interest of the results are discussed.—Author's abstract

02008 **Bottinga, Y.; Craig, H.** Oxygen isotope fractionation between CO_2 and water, and the isotopic composition of marine atmospheric CO_2: Earth and Planetary Sci. Letters, v. 5, no. 5, p. 285-295, illus., tables, 1969.

The fractionation factor for oxygen isotope exchange between CO_2 and liquid water has been measured as 1.0409 ± 0.0002, in agreement with the recent value of O'Neil and Epstein. The temperature variation has been measured between 0-45°C and corresponds to about 0.2 per mil/°C in this range. Both the absolute value and the temperature variations are in agreement with the theoretical calculations based on the most recent spectroscopic data. Atmospheric CO_2 over the oceans does not appear to be in local isotopic equilibrium with adjacent water, although to first order this exchange regulates the average composition of the CO_2. Exchange with atmospheric water appears to be a significant factor in producing isotopic variations in the CO_2.—*from* Authors' abstract

Bouma, A. H. *See* Chmelik, Frank B. 01683

01702 **Bouma, Arnold H.** New type of sediment-distribution map—Preliminary result for Gulf of Mexico [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 707, 1969.

Boustead, J. *See* Axon, H. J. 07466

Bowin, C. O. *See* Uchupi, Elazar. 01576

01703 **Bowin, Carl O.; Phillips, Joseph; Emery, K. O.; Uchupi, Elazar; Knott, S. T.; Prada, K. E.; Bunce, E. T.** Continental rise off east coast of North America—Deep structure [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 707-708, 1969.

01704 **Boyd, Donald W.; Newell, Norman D.** Postmortem history of a Permian pelecypod assemblage from Wyoming [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 708, 1969.

01912 **Boyd, Donald William.** Simulation via time-partitioned linear programming—A ground and surface water allocation model for the Gallatin Valley of Montana [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2865B, 1969.

Boyd, F. R. *See* Bell, Peter M. 07412

Brace, W. F. *See* Greenberg, Richard J. 01713

01729 **Brace, W. F.; Scholz, C. H.; LaMori, P. N.** Isothermal compressibility of kyanite, andalusite, and sillimanite from synthetic aggregates: Jour. Geophys. Research, v. 74, no. 8, p. 2089-2098, illus., tables, 1969.

A compressibility determination technique is described in which an unknown mineral, available only in small quantities and in finely divided form, is mixed with a ductile solid of known characteristics; from measurements on hot-pressed samples of the aggregate and the known properties of the matrix, properties of the unknown mineral can be derived by a Voigt-Reuss averaging procedure. An accurate result requires a close matching of the properties of matrix and unknown. Using this method, the compressibility of kyanite, andalusite, and sillimanite have been determined in a hydrostatic system to 10 kb and in a solid medium system to 40 kb. In all three, compressibility at 1 bar and 25°C was within 0.77 ± 0.04 Mb^{0-1}. The technique can serve principally as an exploratory tool. Only about 2 g of powdered material are required.—DBV

01756 **Brace, W. F.** The mechanical effects of pore pressure on fracturing of rocks, *in* Research in tectonics: Canada Geol. Survey Paper 68-52, p. 113-123, illus., table; discussion, p. 124, 1969.

Experiments were conducted to determine if the law of effective stress holds for crystalline rocks of low porosity, such as granite and dunite. Tests showed that the law holds for these only when the loading rate is less than some critical value. The critical value depends upon permeability, viscosity of pore fluid, and sample geometry. The form and orientation of fractures was in no way dependent on the presence of fluids or on strain rate. In experiments at loading rates greater than the critical value, the rock under pore pressure is stronger than it is under zero pore pressure. This can be explained by the dilitancy hardening of Frank (1965). For very ductile rocks, such as marble, this effect is enhanced by a marked reduction in permeability traced to sealing off of the pore structure, due to plastic flow of calcite.—*from* Author's abstract

01735 **Braddock, R. D.** On tsunami propagation: Jour. Geophys. Research, v. 74, no. 8, p. 1952-1957, illus., tables, 1969.

The propagation of the Alaskan tsunamis of 1946 and 1964 has been studied using an iterative algorithm designed to handle continuous optimal problems. The results of calculations for the 1946 tsunami to Sitka demonstrate its capabilities and show that the great circle does not always furnish reliable approximations to the traveltime and

path. Calculations for the 1964 tsunami permit the description of its propagation and the plotting of the ray paths to locations along the American coast. In the southwest Pacific, most of the wave train was dispersed by the complex bathymetry northeast of Australia but some wave energy passed through the Fiji basin into the Tasman Sea. The reflection of the wave by the Undulla Deep explains the late arrivals in New Zealand and the remarkable tide record from Macquarie Island.—Author's abstract

02030 **Bradley, W. H.** Vertical density currents—[Pt.] 2: Limnology and Oceanography, v. 14, no. 1, p. 1-3, illus., 1969.

An earlier paper bearing the same title (Bradley, 1965), reported the author's experiments on the settling, in static fluids, of particles with diameters of <0.14 mm by formation of vertical density currents, which flow downward in cylindrical stream tubes from a near-surface layer. Purpose of the experiments was to simulate settling of microscopic particles in natural environments, such as diatom frustules and calcite crystals in eutrophic lakes. The present paper reports two experiments by other authors in virology and mycology, which demonstrate vertical density currents wholly within the domain of laminar flow, in water and air respectively, and show that a clearly defined near-surface layer of uniformly dispersed particles forms first and that the currents originate and flow from the lowest part of this layer.—VMJ

01705 **Braislin, Dana B.** Geology of part of outer continental shelf off Oregon [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 708-709, 1969.

01823 **Braun, Moshe; Friedman, Gerald M.** Carbonate lithofacies and environments of the Tribes Hill Formation (Lower Ordovician) of the Mohawk Valley, New York: Jour. Sed. Petrology, v. 39, no. 1, p. 113-135, illus., tables, 1969.

The formation was deposited within a broad, shallow epicontinental sea. Ten lithofacies were deposited in three distinct depositional environments: supratidal, intertidal, and subtidal. Supratidal sediments are mottled or laminated dolomite which tends to be feldspathic, contains bituminous material, and shows birdseye textures and undulating stromatolitic structures. Fossils are absent. Intertidal sediments have tidal flat and tidal channel facies. Subtidal sediments are well-bedded lime mudstones and calcarenites with oölids, abundant skeletal fragments, and intraclasts. The depositional history is outlined.—*from* Authors' abstract

01724 **Braun, R. L.; Kahn, J. S.; Weissmann, S.** X-ray diffraction analysis of plastic deformation in the Salmon event: Jour. Geophys. Research, v. 74, no. 8, p. 2103-2117, illus., 1969.

X-ray diffraction rocking curve studies were combined with X-ray topography of halite crystals taken from the Tatum salt dome before and after the 5-kT Salmon nuclear explosion. Results of these measurements indicated that beyond a radial distance of 126 m from the shot point the halite had experienced no detectable shock-induced plastic deformation. At distances less than 126 m the strain accomodation consisted of intragranular gliding on multiple slip systems and localized rotation of substructural lattice regions with respect to each other. This turbulent plastic deformation led to pronounced lattice kinking and eventually to a general fragmentation of the halite crystals. It was inferred from the data that excessive accumulation of long-range stresses was absent and that the shocked structure tended to assume a configuration of low lattice strain.—*from* Authors' abstract

01706 **Bray, R. G.; Beerbower, J. R.** Paleoecologic analysis of some middle Devonian fossil aggregations [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 709, 1969.

07469 **Brett, Robin.** Metallic spherules in impactite and tektite glasses [abs.], *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 623, 1968.

07358 **Bricker, Owen P.** Cations and silica in natural waters—Control by silicate minerals, *in* Geochemistry, precipitation, evaporation, soil-moisture, hydrometry—General

Assembly of Bern, 1967, Repts. and Discussions: Internat. Assoc. Sci. Hydrology Pub. 78, p. 110-119, illus., tables, 1968.

Natural waters acquire their chemical characteristics by reacting with materials they contact, of which 70 percent or more are silicate minerals. Analyses of waters from a variety of silicate rocks reveal a very narrow range of silica concentrations. A laboratory study with distilled water shows that feldspars react rapidly releasing silica and cations. The geochemical balance of a small watershed near Baltimore, Md., underlain by silicate bedrock was investigated. Stream water composition remained constant during the year except during flood, and aluminum appears to be relatively immobile. Water-silicate reactions are rapid and regulate concentration of a number of species. Contributions of each mineral to the dissolved load can be assessed by reconstituting the original minerals from products of weathering. Most dissolved constituents can be accounted for by breakdown of oligoclase alone.—ESL

07441 **Briggs, Louis I.; Zigic-Toshich, Darinka.** Coordinate evaluation of evaporite deposits by dynamic modelings and simulation, *in* Forum on geology of industrial minerals, 4th, Austin, Tex., 1968, Proc.: Austin, Tex., Univ. Texas Bur. Econ. Geology, p. 99-115, illus., 1968.

Quality, form, distribution, and relation of stratigraphic components are identified by systematic analysis of distributive patterns of deposit types and their associative elements. The Salina Group was deposited in the reef-rimmed Michigan basin. Rock salt makes up 75 percent of the evaporites. The Detroit River Group has a lower carbonate-sulfate phase all over the Michigan basin, and an upper complex carbonate-sulfate-chloride phase is restricted largely to the center of the basin. A central basin-sabhka model best fits this type. The Mississippian Michigan Formation is primarily a shallow marine shale-dolomite-anhydrite sequence with strong facies zonation. Deposition was in a marginal shallow basin, having pseudomarine and brackish water zonation adjacent to the distal margins subject to periodic influx of terrestrial silicate mud and silt.—*from* Authors' abstract

Brookins, Douglas G. *See* Chaudhuri, Sambhudas. 01835

01707 **Brooks, James E.; Wermund, E. G.; Williams, Thomas E.** Shallow shelf sedimentation in rock record—Introduction to symposium [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 709, 1969.

01566 **Brosgé, William P.; Tailleur, Irvin L.; Gryc, George.** Mineral resources of northern Alaska [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 709-710, 1969.

01941 **Brown, James Alexander, Jr.** Thrust contact between Franciscan Group and Great Valley sequence northeast of Santa Maria, California [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3361B-3362B, 1969.

07446 **Brown, L. F., Jr.** (editor). Fourth forum on geology of industrial minerals, Austin, Tex., 1968, proceedings: Austin, Tex., Univ. Texas Bur. Econ. Geology, 174 p., illus., tables, 1968.

This symposium, held in March, 1968, at Austin, Texas, contains sixteen papers (cited individually) dealing with economic geology. Following a keynote paper, there are ten concerning the geology of chemical raw materials and five concerning depositional models in economic stratigraphy.—HRC

01981 **Brown, S. G.; Schumann, H. H.** Geohydrology and water utilization in the Willcox basin, Graham and Cochise Counties, Arizona: U.S. Geol. Survey Water-Supply Paper 1859-F, p. F1-F32, illus., tables, geol. map, 1969.

This basin in southeastern Arizona probably formed during middle and late Tertiary in an area of large-scale block faulting. Rocks of the uplifted ranges, Precambrian through Tertiary in age, bear water depending on degree of weathering and fracture. In closed basins are large quantities of Tertiary and Quaternary alluvium, moderately to poorly consolidated and unconsolidated; stream deposits and lake beds associated

with an old playa have interbedded lenticular sand and gravel layers, the principal aquifers, some less permeable and more homogeneous than others. Ground water naturally moves toward the playa at 54,000 to 75,000 acre-feet per year, but increased pumping has changed the piezometric surface; cones of depression expanded and water levels declined in recharge areas along mountain fronts, in some wells as much as 74 feet in 12 years.—GDC

02009 **Brunfelt, A. O.; Steinnes, E.** Antimony content of some standard rocks: Earth and Planetary Sci. Letters, v. 5, no. 5, p. 282-284, table, 1969.

In this paper, neutron activation analysis results for antimony in nineteen primary standard rocks are reported, namely nine standards from the U.S. Geological Survey, four from Zentrales Geologisches Institut, Berlin (DDR), one from the Carpatho-Balkan Geological Association, four from Centre de Recherches Pétrographiques et Géochimiques, Nancy (France), and one from the Geological Survey of Tanganyika.—*from* Authors' introduction

02013 **Brydon, J. E.; Singh, S. Shah.** The nature of the synthetic crystalline basic aluminum sulphates as compared with basaluminite: Canadian Mineralogist, v. 9, pt. 5, p. 644-654, illus., tables, 1969.

Basaluminite, $Al_4(OH)_{10}SO_4 \times 5H_2O$ from Northamptonshire and Kansas showed reversible expansion and contraction equivalent to 1 layer of interlayer adsorbed water between 100 percent and 0 percent (over P_2O_5) relative humidity. This characteristic supports the previous suggestion that the crystalline basic aluminum sulfate formed upon aging the partially neutralized solution of $Al_2(SO_4)_3$ in the presence of montmorillonite was basaluminite. In the absence of clay, the crystalline basic aluminum sulfates that formed at 50°C, had compositions, thermal analysis features, and solubility products similar to basaluminite but had a slightly different crystalline form.—Authors' abstract

07431 **Brydon, J. E.; Kodama, H.; Ross, G. J.** Mineralogy and weathering of the clays in orthic podzols and other podzolic soils in Canada [with French and German summ.], *in* Internat. Cong. Soil Sci., 9th, Adelaide, Australia, 1968, Trans., V. 4: New York, American Elsevier Publishing Co., p. 41-51, illus., tables, 1968.

Clays from the C horizons ranged from well-ordered mica and chlorite mixtures to a mixture of amorphous material and a poorly crystallized "14A mineral"; smectite was not a common constituent. Clays from the Ae horizon showed the major mineral to be well-crystallized smectite with varying degrees and kinds of mica interstratification; orthochlorites completely disappeared although present in lower horizons; a decrease in mica from the C to the Ae horizon, due partly to preferential rather than random removal of *K* along an entire plane; there was no evidence of major kaolinite formation in the Ae horizon. Clays in the Gray Brown Podzolic and Gray Wooded soils did not show distinctive horizon differentiation of clay mineralogy. Chlorite persisted in the Ae horizons; there was a gradual increase in hydrated-layer minerals from the C horizon to the Ae.—*from* Authors' summary

07425 **Buerger, M. J.; Dollase, W. A.** The possible bonding between aluminum atoms in rhodizite and other crystals [abs.], *in* Internat. Mineralog. Assoc., 5th Gen. Mtg., Cambridge, England, 1966, Papers and Proc.: London, Mineralog. Soc., p. 169, 1968.

02037 **Bukry, David.** Upper Cretaceous coccoliths from Texas and Europe: Kansas Univ. Paleont. Contr., art. 51, Protista 2, 79 p., illus., tables, 1969.

Electron microscopy of the chalk from this interval reveals 172 species of Coccolithophyceae. Of these, 94 species are new, and of the 48 genera represented, 11 are new. Two distribution tables are presented, one arranged by stratigraphic first occurrence and the other alphabetically. The bulk of the Santonian-Campanian coccolith floras, in both Texas and Europe, are composed of 41 long-ranging and abundant species. Santonian-age samples contain 105 species, 53 appearing first in the Santonian; the Campanian contains 137 species, of which 51 are not present in

the Santonian. Four new coccolith assemblage zones are recognized: *Cyclagelosphaera(?) chronolitha* Zone; *Amphizygus minimus* Zone; *Zygodiscus macleodae* Zone; and *Prediscosphaera germanica* Zone.—*from* Author's abstract

01679 **Bull, William B.** Recognition of alluvial-fan environments in stratigraphic record [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 710, 1969.

Bunce, E. T. *See* Uchupi, Elazar. 01576

Bunce, E. T. *See* Bowin, Carl O. 01703

07457 **Bunch, T. E.** Some characteristics of selected minerals from craters, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 413-432, illus., 1968.

Deformational microstructures observed in quartz, feldspar, and mica of rock samples from meteorite impact craters and from a number of cryptoexplosion structures exhibit certain features that are considered due to shock loading and can be distinguished from those produced by tectonic processes. These include brittle fractures, deformation lamellae, multiple sets of planar features, and deformation and kink bands in quartz and associated feldspars, and intricate kinking of mica.—MS

07467 **Bunch, T. E.; Cassidy, William A.** Impact-induced deformation in the Campo del Cielo meteorite, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 601-612, illus., table, 1968.

The deformation appears more intense than that commonly observed in meteoritic irons, but is similar to deformation textures observed in Henbury, Sikhote-Alin, and some Cañon Diablo specimens. No correlation has been found in the Campo del Cielo specimens between intensity of deformation and proximity to the meteorite craters.—*from* Authors' abstract

07482 **Bunch, T. E.; Cohen, Alvin J.; Dence, M. R.** Shock-induced structural disorder in plagioclase and quartz, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 509-518, illus., tables, 1968.

The physical properties of the isotropic pseudomorph of plagioclase, maskelynite, and those of coexisting disordered quartz have been studied in shocked materials from the Sedan nuclear crater ejecta. Similar material has also been studied from the Ries Crater, Germany, together with maskelynite from West Clearwater Lake and Manicouagan, Quebec, Canada, and from the Shergotty meteorite. It is concluded that the natural maskelynite and disordered quartz samples were formed by shock pressures in excess of 150 kb, probably through hypervelocity meteorite impact.—*from* Authors' abstract

Bunch, T. E. *See* Short, N. M. 07497

07499 **Bunch, T. E.; Quaide, W. L.** Shatter cones in the Danny Boy nuclear crater, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 285, illus., 1968.

The shatter cones occur in blocks of subandesite designated as moderately shocked. Petrographic deformation features include fine fractures in plagioclase and olivine, reduced birefringence, and glass stringers.—MS

01844 **Burger, John A.; Klein, George deVries; Sanders, John E.** A field technique for making epoxy relief-peels in sandy sediments saturated with saltwater: Jour. Sed. Petrology, v. 39, no. 1, p. 338-341, illus., 1969.

A quick-setting epoxy mixture is available that enables relief-peels to be made in the field for revealing primary sedimentary structures in sandy sediments. The mixture consists of five parts each of CIBA Epoxy 6005 and CIBA Epoxy 6010, three parts of

CIBA Hardener 850 and one part of CIBA Hardener 830. Polymerization generally occurs within 1.5 hours and is not inhibited by either freshwater or saltwater. An additional four hours is required for curing. Depth of impregnation is controlled by sediment texture, sorting, and permeability. Moisture and low temperatures inhibit polymerization; the method is not recommended for temperatures below 45°F.—Authors' abstract

Burlingame, A. L. *See* Han, Jerry. 01979

Burnett, D. S. *See* Bogard, D. D. 02018

07405 **Butkovich, T. R.** Gas equation of state of natural materials, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 83-85, table, 1968.

In a contained nuclear explosion, the material immediately surrounding the explosive is vaporized by the extremely high temperatures and pressures generated when the energy is released. This expanding gas works on the surrounding medium and causes it to deform and fail, and to form a crater if the depth of burst is sufficiently shallow. With the gas equation of state as input, unloading adiabats are calculated, and it is shown that the radius of vaporization scales as the cube root of the energy.—*from* Author's abstract

01942 **Butler, John Charles.** Selected aspects of the crystal chemistry of $BaSO_4$, $SrSO_4$, and $PbSO_4$ [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3362B, 1969.

02043 **Butler, P., Jr.** Mineral compositions and equilibria in the metamorphosed iron formation of the Gagnon region, Quebec, Canada: Jour. Petrology, v. 10, no. 1, p. 56-101, illus., 1969.

Specimens of the Precambrian Wabush Iron Formation from ten outcrop areas were analyzed for their coexisting minerals. Regularity in the distribution of Fe, Mn, and Ca between pairs of coexisting minerals shows that equilibrium had been attained in most of the rocks studied. Compositional relations indicate that dolomite-ankerite and magnesite-siderite are equilibrium phases, but phase rule considerations suggest that dolomite-ankerite and ankerite-siderite do not represent equilibrium assemblages. Variations in orthopyroxene compositions in assemblages with pyrite or pyrrhotite (or both) and magnetite reflect non-equilibration of sulfides with silicates. The mechanism of volatile loss is discussed with reference to the relatively low gradients of the chemical potentials of H_2O and CO_2 along strike and their relatively high values across strike.—MS

02032 **Button, D. K.** Effect of clay on the availability of dilute organic nutrients to steady-state heterotrophic populations: Limnology and Oceanography, v. 14, no. 1, p. 95-100, illus., 1969.

The effect of clays on the availability of small organic molecules to microorganisms was determined. This experiment is pertinent to the effect of high suspended-sediment loads in the glacier-fed bays and inlets of southeastern Alaska. Recovered suspended clay from Glacier Bay and standard clay prepared from South Dakota bentonite were tested for their ability to compete with yeast and bacteria for thiamine or glucose in continuous culture systems at low organism concentrations. The added clays do not render the organics tested unavailable to microorganisms or remove them from solution to a detectable or significant extent. The addition of clays can, however, effect a perturbation to the steady system, possibly by altering the inorganic chemistry of the dissolved phase.—*from* Author's abstract

01680 **Buzas, Martin A.** Foraminiferal densities and environmental variables—Use of statistical models to examine estuarine environment [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 710, 1969.

07396 **C. L. Herrick Geology Society.** (compiler). 19th annual Ohio Intercollegiate Geology Field Conference, October 12, 1968: Granville, Ohio, Denison University, [55] p., illus., 1968.

The regional geology of central Ohio is reviewed and the Silurian to Permian section shown. The text accompanying the road log is divided into six appendixes including: stratigraphy and paleontology of the Newark road cut; description of the Black Hand Formation and origin of Black Hand Narrows; origin of the flint in the Vanport Limestone at Flint Ridge, and the archeology of the Ridge; a discussion of the Maxville Formation; Mississippian paleoenvironment of central Ohio; and early drainage patterns of the Newark area.—ESL

01876 **Cachau-Herreillat, F.** Geochemical prospecting for lead-zinc stratiform deposits—Nonlinear correlations between the content of soils and rocks in lead and zinc and their use in separating stratiform and hydrothermal deposits, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 95-110, illus., 1969.

The results of soil sampling in the Gatuzières area, France, where syngenetic deposits of sphalerite in dolomitic strata and quartz sulfide veins with galena, sphalerite and copper sulfides are supposed to coexist, showed two types of anomalous areas: (1) a Pb anomaly correlated with tectonic features, and (2) a Zn anomaly with minor Pb correlated with stratigraphic features (strata). Pb-Zn correlation diagrams were constructed. In the stratiform anomaly the correlation coefficient is higher than in the tectonic anomaly and the ratio log Zn/log Pb is about 2. This suggests a statistical correlation between Pb and Zn in stratiform deposits, $Pb^2/Zn=K$, which seems to be characteristic of syngenetic deposits.—KAF

Cadigan, Robert A. *See* Manger, G. Edward. 01832

Cady, J. G. *See* Flach, K. W. 07418

07419 **Cady, J. G.; Daniels, R. B.** Genesis of some very old soils—The Paleudults [with French and German summ.], *in* Internat. Cong. Soil Sci., 9th, Adelaide, Australia, 1968, Trans., V. 4: New York, American Elsevier Publishing Co., p. 103-112, illus., table, 1968.

Soils on old landscapes in the Atlantic Coastal Plain of southeastern United States are thick and have complex horizons. [Field observations of Paleudults of different ages and associated Aquults and Hapludults, in the Benson area of North Carolina, and laboratory data from other states indicate that results and conclusions apply in a general way to other areas.] Geomorphic evidence shows that the land surfaces are late Miocene to very early Pleistocene. Horizon and solum thickness, clay weathering and movement, and plinthite development appear to increase with age but also differ with environment among soils of the same age. Soils on old surfaces may owe their characteristics to the conditions produced by landscape development as much as to the effect of time itself.—Authors' summary

01919 **Callender, Edward.** The postglacial sedimentology of Devils Lake, North Dakota [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2938B-2939B, 1969.

Calvin, Melvin. *See* Han, Jerry. 01979

01766 **Canada Geological Survey.** Aeromagnetic series, Rivière Mannerelle, Quebec: Canada Geol. Survey Geophysics Paper 5351, scale 1:63,360, 1969.

01767 **Canada Geological Survey.** Aeromagnetic series, Rivière Harricana, Quebec: Canada Geol. Survey Geophysics Paper 5352, scale 1:63,360, 1969.

01768 **Canada Geological Survey.** Aeromagnetic series, Lac Salomon, Quebec: Canada Geol. Survey Geophysics Paper 5353, scale 1:63,360, 1969.

01769 **Canada Geological Survey.** Aeromagnetic series, Lac René, Quebec: Canada Geol. Survey Geophysics Paper 5359, scale 1:63,360, 1969.

01770 **Canada Geological Survey.** Aeromagnetic series, Lac des Nogeau, Quebec: Canada Geol. Survey Geophysics Paper 5360, scale 1:63,360, 1969.

01771 **Canada Geological Survey.** Aeromagnetic series, Rivière Missisicabi, Quebec: Canada Geol. Survey Geophysics Paper 5361, scale 1:63,360, 1969.

01772 **Canada Geological Survey.** Aeromagnetic series, Lac Paul-Sauvé, Quebec: Canada Geol. Survey Geophysics Paper 5362, scale 1:63,360, 1969.

01773 **Canada Geological Survey.** Aeromagnetic series, Lac Lucie, Quebec: Canada Geol. Survey Geophysics Paper 5363, scale 1:63,360, 1969.

01774 **Canada Geological Survey.** Aeromagnetic series, Rivière Kitchigama, Quebec: Canada Geol. Survey Geophysics Paper 5364, scale 1:63,360, 1969.

01775 **Canada Geological Survey.** Aeromagnetic series, Rivière Lepallier, Quebec: Canada Geol. Survey Geophysics Paper 5365, scale 1:63,360, 1969.

01776 **Canada Geological Survey.** Aeromagnetic series, Lac Bouchier, Quebec: Canada Geol. Survey Geophysics Paper 5366, scale 1:63,360, 1969.

01777 **Canada Geological Survey.** Aeromagnetic series, Lac Maurice, Quebec: Canada Geol. Survey Geophysics Paper 5367, scale 1:63,360, 1969.

01778 **Canada Geological Survey.** Aeromagnetic series, Rivière Nottaway, Quebec: Canada Geol. Survey Geophysics Paper 5368, scale 1:63,360, 1969.

01779 **Canada Geological Survey.** Aeromagnetic series, Lac Chaboullié, Quebec: Canada Geol. Survey Geophysics Paper 5369, scale 1:63,360, 1969.

01780 **Canada Geological Survey.** Aeromagnetic series, Lac Soscumica, Quebec: Canada Geol. Survey Geophysics Paper 5370, scale 1:63,360, 1969.

01781 **Canada Geological Survey.** Aeromagnetic series, Rivière Muskiki, Quebec: Canada Geol. Survey Geophysics Paper 5371, scale 1:63,360, 1969.

01782 **Canada Geological Survey.** Aeromagnetic series, Lac Ouagama, Quebec: Canada Geol. Survey Geophysics Paper 5372, scale 1:63,360, 1969.

01783 **Canada Geological Survey.** Aeromagnetic series, Lac Dana, Quebec: Canada Geol. Survey Geophysics Paper 5373, scale 1:63,360, 1969.

01784 **Canada Geological Survey.** Aeromagnetic series, Lac Poncheville, Quebec: Canada Geol. Survey Geophysics Paper 5374, scale 1:63,360, 1969.

01785 **Canada Geological Survey.** Aeromagnetic series, Lac Opataouaga, Quebec: Canada Geol. Survey Geophysics Paper 5375, scale 1:63,360, 1969.

01786 **Canada Geological Survey.** Aeromagnetic series, Lac Salamandre, Quebec: Canada Geol. Survey Geophysics Paper 5376, scale 1:63,360, 1969.

01787 **Canada Geological Survey.** Aeromagnetic series, Lac Evans, Quebec: Canada Geol. Survey Geophysics Paper 5377, scale 1:63,360, 1969.

01788 **Canada Geological Survey.** Aeromagnetic series, Lac Persevil, Quebec: Canada Geol. Survey Geophysics Paper 5378, scale 1:63,360, 1969.

01789 **Canada Geological Survey.** Aeromagnetic series, Lac Amisquioumisca, Quebec: Canada Geol. Survey Geophysics Paper 5379, scale 1:63,360, 1969.

01790 **Canada Geological Survey.** Aeromagnetic series, Lac Rocher, Quebec: Canada Geol. Survey Geophysics Paper 5380, scale 1:63,360, 1969.

01791 **Canada Geological Survey.** Aeromagnetic series, Lac Théodat, Quebec: Canada Geol. Survey Geophysics Paper 5381, scale 1:63,360, 1969.

01792 **Canada Geological Survey.** Aeromagnetic series, Lac Caupichigau, Quebec: Canada Geol. Survey Geophysics Paper 5382, scale 1:63,360, 1969.

01793 **Canada Geological Survey.** Aeromagnetic series, Lac Capichigamau, Quebec: Canada Geol. Survey Geophysics Paper 5383, scale 1:63,360, 1969.

01794 **Canada Geological Survey.** Aeromagnetic series, Lac Lerac, Quebec: Canada Geol. Survey Geophysics Paper 5384, scale 1:63,360, 1969.

01795 **Canada Geological Survey.** Aeromagnetic series, Lac Deriares, Quebec: Canada Geol. Survey Geophysics Paper 5385, scale 1:63,360, 1969.

01796 **Canada Geological Survey.** Aeromagnetic series, Lac Dumas, Quebec: Canada Geol. Survey Geophysics Paper 5386, scale 1:63,360, 1969.

01797 **Canada Geological Survey.** Aeromagnetic series, Lac Comencho, Quebec: Canada Geol. Survey Geophysics Paper 5387, scale 1:63,360, 1969.

01798 **Canada Geological Survey.** Aeromagnetic series, Lac Assinica, Quebec: Canada Geol. Survey Geophysics Paper 5388, scale 1:63,360, 1969.

01799 **Canada Geological Survey.** Aeromagnetic series, Lac Augrat, Quebec: Canada Geol. Survey Geophysics Paper 5389, scale 1:63,360, 1969.

01800 **Canada Geological Survey.** Aeromagnetic series, Lac Opataca, Quebec: Canada Geol. Survey Geophysics Paper 5390, scale 1:63,360, 1969.

01801 **Canada Geological Survey.** Aeromagnetic series, Lac Regnault, Quebec: Canada Geol. Survey Geophysics Paper 5391, scale 1:63,360, 1969.

01802 **Canada Geological Survey.** Aeromagnetic series, Lac Troïlus, Quebec: Canada Geol. Survey Geophysics Paper 5392, scale 1:63,360, 1969.

01803 **Canada Geological Survey.** Aeromagnetic series, Baie Pénicouane, Quebec: Canada Geol. Survey Geophysics Paper 5393, scale 1:63,360, 1969.

01804 **Canada Geological Survey.** Aeromagnetic series, Lac Artaud, Quebec: Canada Geol. Survey Geophysics Paper 5394, scale 1:63,360, 1969.

01805 **Canada Geological Survey.** Aeromagnetic series, Lac Bueil, Quebec: Canada Geol. Survey Geophysics Paper 5395, scale 1:63,360, 1969.

07374 **Canada Geological Survey.** Aeromagnetic series, Sheets 43 C/13 and 43 C/14, District of Kenora, Ontario: Canada Geol. Survey Geophysics Papers 3856 and 3877, scale 1:63,360, 1968.

Capitonova, T. A. *See* Perrault, Guy. 02010

Carmichael. J. S. E. *See* Nicholls, J. 01762

01910 **Carpenter, Roy.** The marine geochemistry of fluorine [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2796B, 1969.

07505 **Carrigy, Maurice A.** Evidence of shock metamorphism in rocks from the Steen River structure, Alberta, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 367-374, illus., table, 1968.

Cores of shattered crystalline plutonic and pyroclastic rock, recovered from a well drilled on a Precambrian horst beneath 600 feet of undisturbed Lower Cretaceous strata in northwestern Alberta, are believed to have been produced by a violent shock event in early Cretaceous time. The stratigraphic sequence and the nature of the rocks is consistent with the hypothesis that the well penetrated an ancient crater.

Insufficient data are available to determine whether the crater was produced by the impact of a meteorite or by an intracrustal explosion.—Author's abstract

07490 **Carter, Neville L.** Dynamic deformation of quartz, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 453-474, illus., 1968.

Basal deformation lamellae, faults parallel to crystal forms of low indices, planar features, and crystal cleavage observed in quartz from eight explosive or cryptoexplosion structures are described with reference to their significance as criteria for identifying deformation under dynamic rather than static loading. The rare occurrence of basal deformation lamellae in tectonites and calculation of the stress levels required for their development favor origin by impact of extraterrestrial bodies. The other microstructures, although not exclusively diagnostic of meteorite impact origin, are associated with very high stress levels such as are produced by impact of extraterrestrial bodies and are not yet known to occur in structures produced by intraterrestrial energy sources.—MS

Cassidy, Martin M. *See* Tierney, F. Lyle. 07390

Cassidy, William A. *See* Bunch, T. E. 07467

07449 **Cathcart, James B.** Phosphate in the Atlantic and Gulf Coastal Plains, *in* Forum on geology of industrial minerals, 4th, Austin, Tex., 1968, Proc.: Austin, Tex., Univ. Texas Bur. Econ. Geology, p. 23-34, illus., tables, 1968.

Economic deposits of phosphorite are confined to the Atlantic Coastal Plain and are known only in Middle Miocene or younger rocks. Phosphate pellets are particularly widespread from North Carolina to Florida in middle Miocene rocks although some pellets are found in rocks from Cretaceous to Holocene age. In the Gulf Coastal Plain, phosphate is widespread only in Cretaceous to Paleocene rocks. The deposits are in part structurally controlled; all are in basins on the north or east sides of the positive areas, except for those in south Florida. The phosphorus was supplied by cool, southward-moving ocean currents which were diverted from the Gulf Coastal area by Florida. The deposits from North Carolina to Florida are grossly similar.—*from* Author's abstract

01681 **Cavaroc, Victor V., Jr.** Delineation of some outer deltaic plain subenvironments based on sedimentary properties in vertical section [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 710-711, 1969.

Cepek, Pavel. *See* Hay, William W. 01652

01682 **Chamberlain, C. Kent.** Trace fossils, basin migration, sedimentation, and bathymetry of Ouachita geosyncline of Oklahoma [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 711, 1969.

01886 **Chan, Samuel S. M.** Suggested guides for exploration from geochemical investigation of ore veins at the Galena Mine deposits, Shoshone County, Idaho, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 139-168, illus., tables, 1969.

Among all minor and trace elements that have been detected in samples of the vein materials from the Galena mine near Wallace, Idaho, three elements (Hg,As,Zn) may be used as indicators of mineralization because of their mobilities, dispersion patterns, and their positive correlations with the major ore minerals. Geochemical anomalies of one of the three elements may not often be used as evidence of the presence of ore body but as an indication of nearby mineralization. The occurrence of high anomalies of more than one element may be more conclusive. The detection and plotting of these three elements together with the mapping of the structural details is suggested. Careful interpretation may then lead to the discovery of new ore bodies.—KAF

07491 **Chao, E. C. T.** Pressure and temperature histories of impact metamorphosed rocks—Based on petrographic observations, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 135-158, illus., 1968.

This paper interprets observed shock effects on granitic and other crystalline and metamorphic rock fragments of the fallout breccia of Ries crater of southern Germany and Lake Bosumtwi crater of Ghana, Africa. Deformation features, evidence of partial, complete or selective phase transitions and of breakdown, decomposition, and melting of quartz, plagioclase, biotite, amphibole, magnetite, ilmenite, titanite, rutile, and zircon are described and classified. To interpret shock features, diagrams showing pressure and temperature histories of fragments metamorphosed by impact-induced shock waves are given in terms of a concept of the formation of the fallout breccia during crater-forming events. Estimates of pressures and temperatures indicated by observed shock effects are derived from comparison with available shock wave experimental data on single crystals of quartz and plagioclase.—*from* Author's abstract

01757 **Charlesworth, H. A. K.** Some observations on the age of jointing in macroscopically folded rocks, *in* Research in tectonics: Canada Geol. Survey Paper 68-52, p. 125-134, illus., table; discussion, p. 134-135, 1969.

The dispersion of joints within associated joint sets, and the extent to which the sets are veined may enable their relative ages to be determined. The relative ages of joint sets in macroscopically folded sandstones belonging to the Cretaceous Cardium Formation in the Bow River area of the Rocky Mountain Foothills are consistent with the possibility that the two stress fields responsible for jointing were modified residuals of the orogenic stress field.—Author's abstract

01920 **Chase, Ronald Buell.** Petrology of the northeastern border zone of the Idaho batholith, Bitterroot Range, Montana [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2939B, 1969.

01835 **Chaudhuri, Sambhudas; Brookins, Douglas G.** The isotopic age of the Flathead Sandstone (Middle Cambrian), Montana: Jour. Sed. Petrology, v. 39, no. 1, p. 364-366, illus., tables, 1969.

The sandstone consists of thick- to thin-bedded, well sorted, clean quartzose and glauconitic sand with thin interbedded red and green fissile shales occurring near the top. Seven samples of the interbedded shales have been dated by the Rb-Sr whole rock method with a resultant age of 555 ± 18 m.y. and initial Sr (87/86) of 0.7183 ± 0.001 as determined by least squares analysis. A single Rb-Sr age on presumed authigenic glauconite yields an age of 542 m.y. using an assumed initial (sea water) Sr (87/86) value of 0.707. Both the shale and the glauconite ages are consistent with a Middle Cambrian age to which the Flathead Sandstone is assigned on geologic evidence. Four samples of shales taken near an andesitic sill have evidently been metamorphosed in such a way as to destroy the original (depositional) Rb-Sr balance.—*from* Authors' abstract

Chave, Keith E. *See* Smith, Stephen V. 07371

07470 **Cherry, J. T.** Cratering mechanics [abs.], *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 624, 1968.

01683 **Chmelik, Frank B.; Bouma, A. H.** Structural and textural descriptions of marine sediments [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 711, 1969.

07388 **Christensen, N. I.; Crosson, R. S.** Seismic anisotropy in the upper mantle: Tectonophysics, v. 6, no. 2, p. 93-107, illus., tables, 1968.

Evidence from laboratory studies of elasticity and petrofabrics suggests that many ultramafic rocks behave macroscopically as transversely isotropic elastic solids.

These results suggest an upper mantle that is transversely isotropic to seismic wave propagation. Where mantle flow is predominantly sheet-like over large regions, as beneath oceans, a normal vertical axis transverse isotropy is suggested. In these regions there is no directional dependence of compressional wave refraction arrivals. Where this pattern is disrupted by rising convection currents or transcurrent faulting, appreciable deviations should occur. If seismic observations substantiate the isotropic behavior, seismic anisotropy will be a powerful tool in determining mantle composition, stress state, convection currents, and type of mechanical behavior associated with convection.—*from* Authors' abstract

07471 **Christie, J. M.** Deformation of quartz in static tests and its relevance for interpretation of impact textures [abs.], *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 624, 1968.

01684 **Chuber, Stewart; Pusey, Walter C.** San Andres (Permian) facies and diagenesis in Reeves Field, Yoakum County, Texas [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 711, 1969.

01720 **Chung, D. H.; Simmons, Gene.** Elastic properties of polycrystalline periclase: Jour. Geophys. Research, v. 74, no. 8, p. 2133-2135, tables, 1969.

New data on the variation with pressure of the elastic parameters of a hot-pressed specimen of MgO are reported. Within the uncertainty of the measurements, the elastic constants are independent of direction but the pressure derivatives are not.—Authors' abstract

Cipra, J. E. *See* Bidwell, O. W. 07437

Clabaugh, Patricia S. *See* Muehlberger, William R. 07455

Claypool, George E. *See* Baker, Donald R. 01692

Cleary, William J. *See* Doyle, Larry J. 07370

01733 **Clifford, P. M.** Kink band development in the Lake St. Joseph area, northwestern Ontario, *in* Research in tectonics: Canada Geol. Survey Paper 68-52, p. 229-241, illus.; discussion, p. 241-242, 362, 1969.

The kinked lamination has, in some folds, been rotated to a position more than 60° removed from σ_1; there is also carbonate filling in kinked laminations of some folds. It appears that the initial folding took place by a simple rotation of laminae about the fold axis. This involved first, a positive and increasing dilation, followed by a positive but decreasing dilation. As dilation passed through zero, gliding occurred except where the kinked lamination was already at too high an angle to σ_1. At this stage any further shortening could only be either by lateral migration of kink zone boundaries or by the inauguration of new kinks elsewhere. This hypothesis implies that the basic geometry of the kink fold is produced by dilation-rotation and gliding, and that lateral migration of kink zone boundaries effects dimensions of the kinked zone.—*from* Author's abstract

01685 **Coch, Nicholas K.; Krinsley, David H.** Comparison of stratigraphic and microscopic evidence for origin of Virginia "terrace" sediments [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 711-712, 1969.

Cocke, J. M. *See* Strimple, H. L. 01597

Cocks, George G. *See* Sclar, Charles B. 07458

Cocks, L. Robin M. *See* Ziegler, Alfred M. 07394

Cohen, Alvin J. *See* Bunch, T. E. 07482

Cok, Anthony E. *See* Stanley, Daniel J. 07381

01686 **Colburn, Ivan P.** Paleocurrent patterns along continental margin of central California during Cretaceous time [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 712, 1969.

01687 **Cole, James M.** Geology of Ventura basin, California, as an approach to exploration of continental margin [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 712, 1969.

01969 **Cole, W. Storrs.** Names of and variation in certain American larger Foraminifera, particularly the Eocene pseudophragminids, No. 4: Bulls. Am. Paleontology, v. 56, no. 248, p. 5-55, illus., 1969.

Eight species of American Paleocene and Eocene larger Foraminifera of the genus *Pseudophragmina*, family Discocyclinidae, are discussed and illustrated. Several of these species have been illustrated inadequately, and in consequence specimens from other localities were described as new species, many of which are considered to be synonyms. The associated foraminiferal and molluscan faunas, wherever possible, are analyzed to assist in defining the stratigraphic position of the species under consideration. The genus *Pseudophragmina* is divided into two subgenera, *Pseudophragmina* ss. and *Athecocyclina*. The formerly recognized subgenus *Proporocyclina* is demonstrated to be a synonym of *Pseudophragmina* ss.—Author's abstract

01688 **Coleman, James M.; Gagliano, Sherwood M.; Ferm, John C.** Deltaic environments [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 712, 1969.

Connell, J. G. *See* Tixier, M. P. 07346

Coogan, A. H. *See* Bebout, Don G. 01698

01689 **Coogan, Alan H.** Compaction effects in oölitic grainstone [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 713, 1969.

07462 **Cook, Beverly Gatlin; Rogers, John J. W.** Radiometry and crystallization history of the Buchanan granite massif, Texas, USA: Lithos, v. 1, no. 4, p. 398-407, illus., tables, 1968.

The massif, a Precambrian pluton covering about 100 sq mi in central Texas, shows a concentric zonation from fine-grained rocks in the interior to coarse-grained and porphyritic near the margin, which can be explained by an equal fugacity distribution of water in the intruded magma shortly after emplacement. The higher water content of the outer zones depressed crystallization temperature below actual temperature, allowing the interior to crystallize first, and progressive crystallization outward increased the water content of the margins. The high water content maintained crystallization in the two phase, subsolidus feldspar region. Radiometric data are characterized by high Th/U ratios and a decrease of radioactive constituents with increasing differentiation. These abnormal concentrations and trends indicate substantial secondary redistribution of thorium and uranium, after primary crystallization.—*from* Authors' abstract

01661 **Cotter, Edward.** Identification and interpretation of Upper Cretaceous fluvial and deltaic sandstones [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 713-714, 1969.

01662 **Coupal, F. E.** Geology of San Andres (Permian) reservoir of part of Wasson field, Gaines and Yoakum Counties, Texas [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 714, 1969.

Craig, H. *See* Bottinga, Y. 02008

01808 **Cramer, Howard Ross.** Evaporites—A selected bibliography: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 4, p. 982-1011, 1969.

This bibliography contains 716 references, most of which are indexed to stratigraphic and geographic locations in North America. The emphasis is placed on the strati—

graphic occurrence of marine evaporites in the well-known, or potential, petroleum-producing sedimentary basins of North America, with the exception of the Gulf of Mexico basin and the Gulf Coast of the United States and Mexico. Most of the references are to sources which are relatively easy to obtain.—Author's abstract

Creager, Joe S. *See* Echols, Ronald J. 01669

01663 **Crosby, Eleanor J.** Classification of sedimentary environments [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 714, 1969.

01885 **Crosby, Garth M.** A preliminary examination of trace mercury in rocks, Coeur d'Alene district, Idaho, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 169-194, illus., tables, 1969.

The relationships of trace-mercury distribution to Precambrian rocks, major ore occurrences, and mineral belts has been studied in the east half of the Coeur d'Alene district, Idaho. With the exception of the Striped Peak Formation which was not sampled, all Precambrian formations contain anomalous mercury. The St. Regis and Revett Formations show the sharpest contrast between in-belt and out-of-belt anomalies. Rocks adjacent to one or both walls of all major veins contain anomalous Hg ranging from less than 100 ppb to several hundred or a few thousand ppb. Profiles of vein anomalies rise abruptly above broad plateaus of less-anomalous Hg which in some cases match surprisingly well with mineral belt limits adopted from an interpretation of geologic structure. Within mineral belts, anomalies range from 600 ppb to 3,000 ppb, while outside mineral belt anomalies highs are less than 500 ppb.—KAF

Crosson, R. S. *See* Christensen, N. I. 07388

Cumming, G. L. *See* Green, D. C. 07481

07494 **Cummings, David.** Shock deformation of biotite around a nuclear explosion, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 211-217, illus., 1968.

Two of the three preferred orientations of kink bands observed in shock-deformed biotite have been obtained in the laboratory under static loading, but the 70° orientation has not, and may prove to be a diagnostic shock feature. Anomalous interference figures apparently also result from the passage of the shock wave.—MS

01664 **Currie, John B.** Stages in fracture-porosity development [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 714, 1969.

07506 **Currie, K. L.** A note on shock metamorphism in the Carswell circular structure, Saskatchewan, Canada, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 379-381, illus., 1968.

Shock metamorphic effects observed in the Carswell structure are attributed to a strong shock wave that was propagated upward through the basement rather than to meteorite impact.—MS

01837 **Cys, John M.** On the term "cryptalgalaminate", a discussion: Jour. Sed. Petrology, v. 39, no. 1, p. 396, 1969.

The abandonment of the term "cryptalgalaminate" in favor of the term "algal mat" is advocated.—Author's abstract

07464 **Dachille, Frank; Gigl, Paul; Simons, P. Y.** Experimental and analytical studies of crystalline damage useful for the recognition of impact structures, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 555-569, illus., tables, 1968.

Asterism of characteristic X-ray diffraction spots, spread of the optic axes of individual fragments of single crystals, and other deformation effects observed in material from shatter cones, meteorite craters, volcanic and metamorphic rock complexes, and explosion sites are reported with a view to the significance of small-scale structural effects that may be characteristic of high-energy impact processes.—MS

01891 **Dahlberg, Eric C.** Use of model for relating geochemical prospecting data to geological attributes of a region, South Mountain, Pennsylvania, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 195-216, illus., table, 1969.

For explaining variation in stream sediment trace metal data as a function of some regional properties, the model T= f(L,H,G,C,V,M,e), has been utilized. The element concentration is a function of: lithologic influences, drainage system effects, geologic structure, cultural influences, natural cover, effects of mineral bodies, and error plus additional factors. The model is applied to an area of native copper occurrences near South Mountain, Pa. When combined with factor analysis the effectiveness of the model as a basis for prediction is enhanced. Use of the model aids in showing not-so-obvious relation among geochemical and regional properties, provides objective ranking criteria for eliminating less useful information, serves as a basis for removing unwanted effects from the data, and is general enough to be applied to any similar type of prospecting problem.—KAF

Damon, Paul E. *See* Livingston, Donald E. 07460

Daniels, R. B. *See* Cady, J. G. 07419

01943 **Davidson, Donald Miner, Jr.** Ore emplacement and associated features, Kane Springs Canyon, Utah [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3362B-3363B, 1969.

01665 **Davis, John C.** Distribution of hydrocarbons in three dimensions [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 714-715, 1969.

Davis, M. R. *See* Banks, H. P. 01982

Day, G. F. *See* Lawson, R. I. 01827

01880 **Debnam, A. H.** The modern geochemical laboratory, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 217-221, 1969.

The colorimetric analytical methods initially developed specifically for geochemical exploration have been largely replaced by atomic absorption methods which have the advantages of simplicity, rapidity, and accuracy, particularly for metals which require complicated colorimetric procedures. Automation appears to be the best solution to multimetal geochemical analyses. There is now available a small direct reading emission spectrometer, ideal for use in mobile laboratories, which can be programmed to determine up to 30 elements.—*from* Author's abstract

07408 **deCarli, Paul S.** Observations of the effects of explosive shock on crystalline solids, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 129-134, 1968.

Although effects similar to those produced by shock waves can also be produced by heating, plastic deformation, or mechanical crushing, certain characteristics exhibited in common by shock-synthesized phases may represent criteria for identification of shocked material. The presence of coesite or stishovite in a sample, the occurrence of networks of veins in some chondrites, and other characteristics that may be considered strong evidence for shock metamorphism are discussed, with the conclusion that unqualified general statements are difficult to construct.—MS

01953 **deJong, Sybren Hendrik.** The skew Mercator projection in rectangular plane coordinate systems [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3367B-3368B, 1969.

01854 **Dellwig, Louis F.; Evans, Robert.** Depositional processes in Salina Salt of Michigan, Ohio, and New York: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 4, p. 949-956, illus., table, 1969.

Salina salt deposits in the center of the Michigan basin are characterized by annual layering and clear and cloudy salt alternations, suggestive of deep-water deposition. Basin-margin salt contains features such as minor unconformities, recrystallized patches, and ripple marks. In the Appalachian basin, a turbulent shallow-water environment is suggested by destruction of salt layering, presence of crossbedding, transported shale balls, and available paleoecological information.—EGS

Dence, M. R. *See* Bunch, T. E. 07482

Dence, M. R. *See* Robertson, P. B. 07489

07492 **Dence, M. R.** Shock zoning at Canadian craters—Petrography and structural implications, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 169-184, illus., table, 1968.

Similar zones of shock metamorphism, defined on the basis of progressive changes in mineral deformation, are recognized in the autochthonous gneisses of the Brent and East Clearwater Lake craters. The former is a simple crater whose floor remained stationary and whose walls slumped considerably during fallout of ejecta; the latter is a complex crater in which the level of adjustment was at greater depth and was accompanied by development of a central uplift. Models for the two types of craters are presented, together with discussion of the cratering mechanism.—MS

07503 **Dence, M. R.; Innes, M. J. S.; Robertson, P. B.** Recent geological and geophysical studies of Canadian craters, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 339-362, illus., tables, 1968.

Field investigations and diamond drilling during 1965-66 resulted in confirmation of shock features at two localities and in identification of shock features at two other localities, thus increasing the number of meteorite craters on the Canadian Shield to twelve. (In an appended note it is reported that the count is now sixteen.) Details of each of the structures are reported. The data indicate that craters formed in plutonic rocks can be classed either as simple craters, characterized by a lens of mixed breccias that is thickest in the center, and complex craters, characterized by the presence of a central uplift of weakly to moderately shocked autochthonous gneisses, blanketing breccias containing fragments exhibiting shock metamorphic features, and a peripheral depression.—MS

Dennis, Leonard S. *See* Zietz, Isidore. 07348

01954 **Dewart, Gilbert.** Seismic investigation of ice properties and bedrock topography at the confluence of two glaciers, Kaskawulsh Glacier, Yukon Territory, Canada [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3363B, 1969.

Dickey, Parke A. *See* Jam L., Pedro. 01625

Dickinson, Kendell A. *See* Berryhill, Henry L., Jr. 01700

01728 **Dieterich, J. H.; Onat, E. T.** Slow finite deformations of viscous solids: Jour. Geophys. Research, v. 74, no. 8, p. 2081-2088, illus., 1969.

A numerical approach to the study of finite, quasi-static, plane deformations of viscous solids is introduced. The problem is formulated in terms of a series of incremental problems. A modified version of the finite element method is employed in the

solution of this series of problems. It is hoped that this approach may prove convenient for the study of certain problems associated with geological structures. The example of the finite compression of a body with an initially imperfect free surface might shed some light on the formation of mullions.—Authors' abstract

07498 **Dietz, Robert S.** Shatter cones in cryptoexplosion structures, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 267-285, illus., table, 1968.

A review of the characteristics of shatter cones associated with cryptoexplosion structures at various localities throughout the world and with the Bosumtwi (Ghana) and Kaalijarv (Estonia) meteorite craters supports the conclusion that shatter cones are diagnostic criteria for identification of ancient meteorite impact scars (astroblemes). Data on the characteristics and orientation of shatter cones are summarized, together with data on conical geologic structures resembling shatter cones, whose formation was not due to shock-loading.—MS

Dill, Charles E., Jr. *See* Swift, Donald J. P. 01956

01813 **Dionne, Jean-Claude.** Tadpole holes—A true biogenic sedimentary structure: Jour. Sed. Petrology, v. 39, no. 1, p. 358-360, illus., 1969.

In the Lake Saint-Jean area (Quebec), circular micro-depressions have been observed in soft layers of silt and fine sand composing the bottom of shallow ponds. Numerous small holes with a diameter of 10 to 20 mm and a depth of 10 mm are regularly spaced over nearly the whole bottom surface. They are made by tadpoles and are called tadpole holes.—Author's abstract

01965 **Doe, Bruce R.; Lipman, Peter W.; Hedge, Carl E.; Kurasawa, Hajime.** Primitive and contaminated basalts from the southern Rocky Mountains, U.S.A.: Contr. Mineralogy and Petrology, v. 21, no. 2, p. 142-156, illus., tables, 1969.

On the basis of the rocks and the region studied, K_2O apparently is the only major element with promise of separating primitive basalt from contaminated basalt inasmuch as it constitutes more than 1 percent in all the obviously contaminated basalts. K_2O/Pb and Th and Rb/Sr are the most indicative of the trace elements studied. Using these criteria, three basalt samples are primitive, and are similar in trace-element contents to those of Hawaii and Japan. Contamination causes the Pb isotope ratios to become less radiogenic, but it has little effect on Sr isotope ratios.—*from* Authors' abstract

Dollase, W. A. *See* Buerger, M. J. 07425

01752 **Donath, F. A.** Experimental study of kink-band development in Martinsburg Slate, *in* Research in tectonics: Canada Geol. Survey Paper 68-52, p. 255-288, illus.; discussion, p. 288-293, 362, 1969.

Kink bands formed in slate at relatively low confining pressure are a brittle phenomenon and represent externally rotated foliation segments of constant length bounded by kink planes of fixed position. Initially straight and parallel kink bands remain so during continued compression, but tend to approach one another because of rotation of foliation segments between them. Rotation is caused by slip on cleavage within the kink band and continues until orientation is such that slip is no longer possible. The inclination of kink planes appears to be independent of confining pressure, total strain, and strain history; the mean value determined from this study is 47.5° to the direction of maximum compression.—*from* Author's abstract

01810 **Douglas, Robert G.** Upper Cretaceous planktonic foraminifera in northern California—Pt. 1, Systematics: Micropaleontology, v. 15, no. 2, p. 151-209, illus., 1969.

Upper Cretaceous strata along the west side of the Sacramento Valley and northern San Joaquin Valley contain a diversified and well-preserved fauna of planktonic

foraminifera. Fifty-six of the stratigraphically important species of this fauna are herein described and illustrated. Three species are described as new.—Author's abstract

07370 **Doyle, Larry J.; Cleary, William J.; Pilkey, O. H.** Mica—Its use in determining shelf-depositional regimes: Marine Geology, v. 6, no. 5, p. 381-389, illus., 1968.

The fine sand-size mica content was determined in over 450 beach, dune, river, estuary, continental shelf, and continental slope sediments from the southern United States Atlantic continental margin. Because of hydraulic equivalence considerations, the mica content can be used to delineate depositional and nondepositional regimes of fine-grained sediments. At the present time deposition of fines in the study area is restricted to a narrow nearshore band and the upper continental slope. The central and outer shelf are areas of winnowing.—Authors' abstract

01944 **Drake, Lon David.** Till studies in New Hampshire [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3363B, 1969.

07347 **Duane, David B.** Sand deposits on the continental shelf—A presently exploitable resource, *in* National symposium on ocean sciences and engineering of the Atlantic Shelf, Philadelphia, 1968, Trans.: Washington, D.C., Marine Technology Soc., p. 289-297, illus., tables, 1968.

Large volumes of sand may be involved in plans for shore restoration and periodic nourishment. It has become increasingly difficult to obtain suitable sand from lagoons or inland sources for beach fill. This difficulty has led to an exploration program focused offshore to explore and inventory deposits for future requirements. To date more than 6,000 statute miles of seismic profiles and more than 900 subbottom cores have been collected. Analysis indicates numerous accumulations in excess of 10 million cubic yards.—*from* Authors' abstract

07468 **Duke, Michael B.** The Shergotty meteorite—Magmatic and shock metamorphic features, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 613-621, illus., tables, 1968.

Evidence is presented in support of the conclusion that the Shergotty meteorite formed in a diabase-like intrusion in which crystallization was rapid but was accompanied by some crystal settling and accumulation, and that it was later subjected to strong shock with which solid-state conversion of plagioclase to maskelynite was associated. Experimental data indicate that post-shock heating never exceeded 400°C.—MS

02020 **Durden, Christopher J.** Gnathostomulida—Is there a fossil record?[discussion of paper by R. J. Riedl, 1969]: Science, v. 164, no. 3881, p. 855, 1969.

The new phylum Gnathostomulida (Riedl, ibid., v. 163, no. 3866, p. 445-452, 1969) injects a new choice into the paleontological controversy surrounding conodonts. It is suggested that conodonts were the cores of endosclerotized circumoral papillae, used to tear up and ingest fungal hyphae and algal mats, by probable benthonic "worms." Microconodonts are probably fossil Gnathostomulida closely related to the living fauna. Conodonts belonged to larger organisms, best considered as the class Conodontiphorida within the phylum Gnathostomulida, filling in part the niche constellation of benthonic browsing organisms now occupied by chitons and snails.—DBV

Dutro, J. T. *See* Armstrong, Augustus K. 01691

07410 **Duvall, George E.** Shock waves in solids, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 19-29, illus., 1968.

Various shock-generating methods are outlined, and the characteristics of the shock waves and their interpretation are discussed. Results of shock-wave research have

proved significant for defining phase changes in the mantle and may ultimately have innumerable applications in geophysical and geologic research.—MS

01882 **Dyck, Willy; Smith, A. Y.** The use of radon-222 in surface waters in geochemical prospecting for uranium, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 223-236, illus., 1969.

From the results of a study of Ra-222 and U concentrations in the surface water of Bancroft, Ontario, and Ottawa-Hull districts, it is deduced that Ra values in lake waters exceeding 5 pc per l and in creeks about 100 pc per l are significant in terms of prospecting for uranium in the areas investigated. Although no clear correlation between Ra and U values in the waters was observed, the results indicated gross areal correlation between Ra or U content of surface waters and uraniferous areas. Ra concentration increases in lakes but shows little change in small creeks in winter. Uranium concentrations decrease markedly in creeks but show little change in lakes in winter. The low cost and simplicity of the Ra method suggest considerable potential as a preliminary reconnaissance geochemical prospecting method.—KAF

01970 **Dyck, Willy.** Field and laboratory methods used by the Geological Survey of Canada in geochemical surveys—No. 10, Radon determination apparatus for geochemical prospecting for uranium: Canada Geol. Survey Paper 68-21, 30 p., illus., tables, 1969.

A radon detection instrument was developed comprising a portable nuclear scaler-timer, a photomultiplier, alpha-sensitive cells made with silver-activated zinc sulphide, and a simple vacuum system. The instrument is suitable for the absolute determination of radon in 30 to 40 water samples per day with a practical lower detection limit of 0.25 picocuries. Evacuated 130 ml cells are filled with air bubbled through 130 ml of sample and the alpha activity determined with the counter. Relative radon and/or thoron concentrations in soil emanations were measured on site with the same instrument using a slightly modified cell. These tests take about 3 to 5 minutes and are carried out by inserting a tube into a hole punched in the ground, pumping air from the hole into the cell with a rubber bulb, and measuring the alpha activity of the air with the counter.—Author's abstract

Dygas, Joseph A. *See* Smith, Stephen V. 07371

Eakin, Thomas E. *See* Moore, Donald O. 07344

01892 **Eaton, Jerome F.** The high-temperature creep of dunite [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2947B, 1969.

01666 **Eaton, Robert W.** Regional distribution of Late Jurassic depositional wedge, upper Gulf Coastal Plain of northeast Mexico and southern United States [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 715, 1969.

01667 **Ebanks, W. J., Jr; High, L. R., Jr.** Comparison of modern island and mainland supratidal-flat carbonate deposits, British Honduras [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 715-716, 1969.

01668 **Echols, Ronald J.; Barnes, Sarah S.** Foraminiferal trends within inner sublittoral zone off coast of Washington [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 716, 1969.

01669 **Echols, Ronald J.; Creager, Joe S.; Holmes, Mark L.; McManus, Dean A.** Holocene oceanography of Chukchi Sea [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 716, 1969.

07421 **Edgar, A. D.** The α-β-$LiAlSi_2O_6$ (spodumene) transition from 5,000 to 45,000 lb/in^2 P_{water}, *in* Internat. Mineralog. Assoc., 5th Gen. Mtg., Cambridge, England, 1966, Papers and Proc.: London, Mineralog. Soc., p. 222-231, illus., tables, 1968.

$LiAlSi_2O_6$ exists as a low-temperature α-form, spodumene, and a high-temperature β-form. The former has a dense pyroxenite-type structure, the latter a much less dense keatite-type. Three high purity natural spodumenes were studied; transition temperatures are between 555° and 630°C in this pressure range. Evidence suggests that determined curves represent equilibrium conditions. Cell-size measurements of the β-form indicate SiO_2 in solid solution, so the transformation cannot be strictly dimorphic. Comparison between transition for the natural mineral and for synthetic material indicates that minor amounts of Na^+ and Fe^{3+} in natural spodumene may increase its stability range. Using the Clayperon equation, values of ΔH for the transformation have been determined as 12,000 ± 3.000 cal/mole.—*from* Author's abstract

Edgerton, A. T. *See* Kennedy, J. M. 07484

07451 **Eifler, G. K., Jr.** Industrial carbonates of the Texas Gulf Coastal Plain, *in* Forum on geology of industrial minerals, 4th, Austin, Tex., 1968, Proc.: Austin, Tex., Univ. Texas Bur. Econ. Geology, p. 45-56, illus., 1968.

Carbonate occurs in Cretaceous formations and oyster shells composing Recent reefs and bays along the Texas coast. The intervening Tertiary rocks contain very little carbonate of commercial importance (about 5 percent of the total carbonates of the area). The Edwards Formation is the chief source of crushed stone and is also pure enough to use as lime. Chalk of the Upper Cretaceous Austin Group is used for cement; one plant uses the Lower Cretaceous Duck Creek Formation. Oyster shells, crushed, are used mainly along the coast for road construction; some are calcined to lime by plants along the coast also. Reserves of Cretaceous carbonates are infinitely great for the foreseeable future.—HRC

01670 **Elam, Jack G.** Fringing reef or allochthonous blocks? [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 716, 1969.

07369 **El-Ashry, Mohamed T.; Wanless, Harold R.** Photo interpretation of shoreline changes between Capes Hatteras and Fear (North Carolina): Marine Geology, v. 6, no. 5, p. 347-379, illus., 1968.

Changes in coastal outline at Capes Hatteras, Lookout, and Fear; near Ocracoke and Snow Marsh; and at Hatteras and Beaufort inlets have been determined from aerial photographs at various times from 1945-1962 and from U.S. Coast and Geodetic Survey charts and field sketches back to 1852. During the period of aerial photography the shoreline has retreated at all three capes, but earlier Capes Fear and Hatteras retreated while Lookout extended seaward. Major storms are the most important in modifying configuration of the North Carolina coastline, but normal shore processes during calm weather tend to redevelop the original smooth outline. Hurricanes cause migration of barriers landward; storms cause migration landward and also southward owing to littoral currents. Inlets migrate southward in the direction of net littoral drift.—VSN

01945 **Ellingson, Jack Anton.** Late Cenozoic volcanic geology of the White Pass-Goat Rocks area, Cascade Mountains, Washington [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3363B, 1969.

01841 **Ellis, Brooks F.** Angelina Rose Messina (1910-1968): Micropaleontology, v. 15, no. 2, p. 133-134, portrait, 1969.

01671 **Ellis, Charles W.** Vibro-box sampler—New tool for study of sedimentary structures in nearshore sands [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 716-717, 1969.

02041 **Elsdon, R.** The structure and intrusive mechanism of the Kap Edvard Holm layered gabbro complex, East Greenland: Geol. Mag., v. 106, no. 1, p. 46-56, illus., table, 1969.

The complex can be divided into three units, here named the Lower, Middle and Upper Layered Series respectively, on the basis of petrochemical data and correction of the dips of the layering for the effects of post-consolidation flexuring. There are no chilled margins, and the contact with the country rock consists of granular basic and ultrabasic rocks, older than the cumulates of the layered series. The intrusive mechanism is considered in the light of field and chemical data.—Author's summary

07367 **Elsik, William.** Palynology of a Paleocene Rockdale lignite, Milam County, Texas—[Pt.] 1, Morphology and taxonomy: Pollen et Spores, v. 10, no. 2, p. 263-314, illus., 1968.

The first part of the palynological study of a Rockdale lignite (Wilcox Group-Paleocene) from Milam County, Texas, involves the fossil palynomorphs, excluding the Dicotyledon. Especially characteristic of certain horizons of the lignite are fungal spores for which several new form genera are proposed. Several fresh water algae are present. Micro- and megaspores of *Isoetes* are recorded. Other modern taxa were identified in the deposit.—*from* Author's abstract

01921 **Elston, Donald Parker.** The geologic classification of the meteorites [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2939B-2940B, 1969.

07500 **Elston, Wolfgang E.; Lambert, Paul Wayne; Smith, Eugene I.** Striated cones—Wind-abrasion features, not shatter cones, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 287-290, illus., 1968.

Examination of cones from a late Tertiary volcanic vent (Cerro Colorado) west of Albuquerque, New Mexico, covered with striae resembling shatter-cone markings, revealed no internal conical fracturing. Unlike true shatter cones, these cones could not be broken from their matrix easily. Comparison with striated cones on residual blocks of Quaternary basalt, weathered in place from a flow, found in a locality south of Albuquerque, suggests that the striae are due to abrasion by wind-blown sand and that the association of the cones with volcanic explosion breccia at Cerro Colorado is coincidental.—MS

Emery, K. O. *See* Uchupi, Elazar. 01576

Emery, K. O. *See* Bowin, Carl O. 01703

07349 **Emery, K. O.** Structure of the continental terrace off the Atlantic coast of the United States and elsewhere in the world [abs.], *in* National symposium on ocean sciences and engineering of the Atlantic Shelf, Philadelphia, 1968, Trans.: Washington, D.C., Marine Technology Soc., p. 277, 1968.

Emery, K. O. *See* Sanders, John E. 07353

01672 **Emery, Kenneth O.** Economic potential of continental rise and slope [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 717, 1969.

Emery, Kenneth O. *See* Fye, Paul M. 07485

01968 **Emmons, Ebenezer.** Reprint in part—Report of the North Carolina Geological Survey—Agriculture of the eastern counties, together with descriptions of the fossils of the marl beds: Bulls. Am. Paleontology, v. 56, no. 249, 230 p., illus., tables, 1969.

The original work, published in 1858, contains many descriptions of Cretaceous and Tertiary fossils from the coastal plain, and these portions of the original report are reprinted. Most are Miocene mollusks, but Cretaceous and Tertiary vertebrates are also included, as are Pleistocene mammals and a few Eocene echinoids and bryozoa.—HRC

01893 **Engdahl, Eric Robert.** Core phases and the Earth's core [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2947B, 1969.

01986 **England, C. B.; Holtan, H. N.** Geomorphic grouping of soils in watershed engineering: Jour. Hydrology, v. 7, no. 2, p. 217-225, illus., tables, 1969.

Soil properties significant to processes of infiltration, moisture storage, drainage, and the hydraulics of surface flow are related to topographic position. Areal and elevational distributions of soils provide a basis for interpretative grouping of soil mapping units in computations for watershed engineering. Soils on an ARS experimental watershed, grouped by deep upland, shallow hillside, and very deep depositional, were plotted on a contour map of the watershed surface. The elevational sequences thus obtained are representative of the hydraulic relationships between hydrologic response units in small agricultural watersheds. Profile characteristics, areal distribution, and relative elevation position of the units determine watershed response to storm rainfall.—Authors' abstract

01673 **Enright, Richard.** Eocene planktonic foraminiferal zonation of New Jersey Atlantic Coastal Plain [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 717, 1969.

01890 **Erickson, Ralph L.** U.S. Geological Survey program in geochemical exploration research, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 237-244, 1969.

The USGS program in geochemical exploration research is fourfold: (1) basic research in geochemistry chiefly in the zone of weathering, (2) research in analytical methods, (3) research in field methods, and (4) analytical support, both in-house and field, of the Wilderness mapping program and the Heavy Metals program. In the basic research program, the following investigations are being made: (1) geochemistry of Hg, (2) weathering geochemistry of Ag and Au, (3) geochemistry and origin of ore-lead. The current emphasis in analytical research is on development of methods for determination of rare metals in near-background concentration and under mobile lab conditions. Current work in field geochemical exploration methods is discussed.—KAF

Erlank, A. J. *See* VonMichaelis, H. 01964

01849 **Esker, George C., 3d.** Planktonic foraminifera from St. Ann's Great River valley, Jamaica: Micropaleontology, v. 15, no. 2, p. 210-220, illus., 1969.

A study of the planktonic foraminifera that occur in the valley of St. Ann's Great River has yielded results that change the previously assigned ages for some of the beds in this inlier. The *Inoceramus* beds range from late Coniacian to late Santonian. The base of the Campanian is at the base of the conglomerate below the *Barriettia* limestone. At least the upper part of the New Ground Conglomerate is Eocene in age.—Author's abstract

Evans, Robert. *See* Dellwig, Louis F. 01854

01674 **Ewing, Maurice.** Deep-water drilling—Atlantic basin [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 717, 1969.

07378 **Faas, Richard W.** An empirical relationship between reflection coefficients and ocean bottom sediments, *in* National symposium on ocean sciences and engineering of the Atlantic Shelf, Philadelphia, 1968, Trans.: Washington, D.C., Marine Technology Soc., p. 149-167, illus., tables, 1968.

The analysis of published geophysical data relating acoustic and geologic parameters reveals that an inverse linear relation exists between the reflection of an acoustic impulse from the ocean bottom and the porosity of the bottom sediments. This relationship has been shown to be consistent for sediments taken from different oceans and different environments within these oceans, as well as for fresh water sediments. However, since the relation of porosity to sediment characteristics is still inadequately known, bottom characteristics should be reported only in terms of porosity variations. Additional research must be directed toward relating porosity to sediment properties if interpretations derived from bottom reflectivity are to be maximized.—*from* Author's abstract

Fagerstrom, J. A. *See* Pabian, Roger K. 07399

07479 **Fairbairn, H. W.; Faure, G.; Pinson, W. H., Jr.; Hurley, P. M.** Rb-Sr whole-rock age of the Sudbury lopolith and basin sediments, *in* Geochronology of Precambrian stratified rocks—Internat. Conf., Edmonton, Alberta, 1967, Papers: Canadian Jour. Earth Sci., v. 5, no. 3, pt. 2, p. 707-714, illus., tables, 1968.

New absolute age data are presented for the sediments and tuff in concordant relation with norite and granophyre of the rimmed elliptical basin at Sudbury, Ontario. An isochron for the slate-graywacke sedimentary sequence in the basin center gives an age of 1720 ± 30 m.y. The norite-granophyre intrusives were previously dated as 1704 ± 19 m.y. No definitive age has been obtained for the underlying tuff but its concordance and chemical relations with sediments and norite-granophyre indicate an equivalent age; combined isotopic data for tuff and sediments give 1684 ± 43 m.y. The study supports consanguinity of the entire complex with rapid development about 1700 m.y. ago.—VSN

01913 **Fan, William Reun-Sen.** The damping properties and the earthquake response spectrum of steel frames [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2866B-2867B, 1969.

02031 **Fanning, Kent A.; Schink, David R.** Interaction of marine sediments with dissolved silica: Limnology and Oceanography, v. 14, no. 1, p. 59-68, illus., 1969.

A sample of Atlantic sea floor sediment, originally in contact with seawater containing 30μM silica, released SiO_2 in amounts greater than expected when placed in silica-poor seawater, but failed to reduce the concentration of silica-enriched (211μM) seawater. The interstitial water from the core held 210μM silica, suggesting that clay-silica equilibria control this concentration. Although lower concentrations may be thus controlled in barren areas, it is far more likely that the resolution of biological silica accounts for the bulk of the interstitial content and for high silica concentrations in cores from productive regions. If all the dissolved silica entering the oceans (about 4×10^{14} g/yr) were adsorbed on newly deposited pelagic clay, it would constitute 20 percent of the weight of the clay, whereas maximum demonstrated adsorption is about 2 percent.—*from* Authors' abstract

Faure, G. *See* Fairbairn, H. W. 07479

Ferguson, William S. *See* Baker, Donald R. 01692

Ferm, John C. *See* Coleman, James M. 01688

01764 **Fisher, D. Jerome; McConnell, Duncan.** Aluminum-rich apatite: Science, v. 164, no. 3879, p. 551-553, illus., table, 1969.

More than 25 atomic percent of Al can substitute for other cations in the structure of apatite [$A_{10}(XO_4)_6Z_2$]. Such a synthetic product was obtained by expelling volatile constituents (H_2O and F) from morinite during thermal treatment. Infrared absorption spectra, chemical analysis, and X-ray powder diffraction demonstrate that the Al has two coordination numbers, and more than twice as much Al substitutes for Ca (A position) as for P(X position).—Authors' abstract

07418 **Flach, K. W.; Cady, J. G.; Nettleton, W. D.** Pedogenic alteration of highly weathered parent materials [with French and German summ.], *in* Internat. Cong. Soil Sci., 9th, Adelaide, Australia, 1968, Trans., V. 4: New York, American Elsevier Publishing Co., p. 343-351, illus., tables, 1968.

In many soils on old land surfaces, the deep weathering product, saprolite, consisting of phyllosilicates, hydrous oxides, and resistant minerals, retains a replica structure of the original rock. It has the chemical and mineralogical properties of phyllosilicate minerals but resembles silt and sand in mechanical, textural and shrink-swell properties. Under pedogenic processes of horizon differentiation, replica rock structure is destroyed and a soil B horizon is formed having soil structure; the texture, water retention and shrink-swell properties change significantly, although mineralogical

composition, surface area and cation exchange capacity may remain nearly constant. Examples are cited from Puerto Rico and southern California.—GDC

01995 **Fleet, M. E.; MacRae, N.** Two-phase hexagonal pyrrhotites: Canadian Mineralogist, v. 9, pt. 5, p. 699-705, illus., 1969.

Microscopic and *X*-ray diffraction studies on two natural specimens of two-phase hexagonal pyrrhotites show that the two unmixed phases have a common crystallographic orientation. In polished section, the common *c*-axis is in the same plane as the short diagonals of the rhombic sections formed by the intersection of the exsolution lamellae. The superstructures of the intermediate hexagonal pyrrhotite in the two samples are different from one another and have not been reported previously from natural material, being hexagonal $2A,6C$ and hexagonal $2A,4C$, where A and C refer to the a and c parameters of the subcell.—Authors' abstract

Fleischer, Michael. *See* Jones, Robert S. 01978

01675 **Flores, Romeo M.** Shallow-water facies of Upper Pennsylvanian Haymond Formation in Marathon basin, Texas [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 717-718, 1969.

01922 **Foit, Franklin Frederick, Jr.** A high temperature study of the anorthite structure and the X-ray diffraction effects of selected tektosilicates displaying superlattice maxima [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2940B, 1969.

01923 **Folger, David Winslow.** Trans-Atlantic sediment transport by wind [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2940B-2941B, 1969.

Folk, Robert L. *See* Ward, William C. 01589

01676 **Fox, Steven K., Jr.; Olsson, Richard K.** Danian planktonic Foraminifera from Cannonball Formation, North Dakota [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 718, 1969.

07442 **Freas, D. H.; Riggs, S. R.** Environments of phosphorite deposition in the central Florida phosphate district, *in* Forum on geology of industrial minerals, 4th, Austin, Tex., 1968, Proc.: Austin, Tex., Univ. Texas Bur. Econ. Geology, p. 117-128, illus., 1968.

Detailed mapping in the Noralyn and Achan mines is reviewed. The Miocene Hawthorn Group consists of the Bone Valley Formation which has a lower Noralyn Member (clayey and/or gravelly phosphorite), and an upper Homeland Member (phosphorite gravel). The Arcadia Formation underlies the Bone Valley. Shoal-water banks and mounds occur between the Arcadia and Noralyn and the main phosphorite deposits are in the shallow-water Noralyn Member. The Homeland Member contains reworked Noralyn material, deposited during a regression. The primary deposition of phosphorite and phosphate replacement of the carbonate substrate occurred in the Noralyn over the banks. The primary phosphorite was partially indurated, disrupted, and fragmented. The Homeland contains no primary phosphorite.—HRC

01677 **Freeland, George L.** Carbonate sediments in clastic environment—Reefs of Veracruz, Mexico [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 718, 1969.

07404 **French, Bevan M.; Short, Nicholas M.** (editors): Shock metamorphism of natural materials, 1st Conf., Goddard Space Flight Center, Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., 644 p., illus., tables, 1968.

The papers in this conference report deal with various aspects of shock metamorphism ranging from results of experimental studies to interpretation of microscopic shock-deformation effects as evidence of meteorite impact origin of large circular structures found in many localities throughout the world. The optical and petro—

graphic effects of shock waves on rocks and minerals were particularly emphasized at the conference. (The papers are cited in this Bibliography under the separate authors.)—MS

07409 **French, Bevan M.** Shock metamorphism as a geological process, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 1-17, illus., 1968.

Evidence is accumulating in support of the theory that meteorite impact may have been responsible for producing uplifts such as the Vredefort ring structure, South Africa, or triggering the release of large amounts of magma from within the earth, as has been suggested for the Sudbury lopolith, Ontario. Among diagnostic shock-metamorphic features are high-pressure effects (production of coesite, stishovite, and other high-pressure polymorphs), high strain-rate effects (development of "planar features" in quartz, transformation of quartz and feldspar grains into maskelynite and other isotropic phases), and high-temperature effects (conversion of quartz to lechatelierite and zircon to baddeleyite). Geologic arguments against meteorite impact are critically evaluated in the light of these criteria, together with known data on the mechanics of shock deformation and impact cratering.—MS

07507 **French, Bevan M.** Sudbury structure, Ontario—Some petrographic evidence for an origin by meteorite impact, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 383-412, illus., 1968.

Planar features in quartz and feldspar and pervasive deformational textures in feldspar crystals identified in inclusions of granitic basement rocks in the Onaping formation are cited as evidence of an impact origin for the Sudbury structure. The data indicate that shock-induced petrographic features can be preserved over long periods of time in spite of metamorphism which may destroy certain diagnostic features, that shatter cones may prove to be diagnostic for meteoritic impact, and that meteorite impacts may be responsible both for triggering or localizing endogenic magmatic activity and for the development of a large circular structure whose later morphology and history reflect volcanic processes.—MC

Friedman, Gerald M. *See* Braun, Moshe. 01823

Friedman, Gerald M. *See* Allen, Robert C. 01825

01856 **Fuller, J. G. C. M.; Porter, J. W.** Evaporite formations with petroleum reservoirs in Devonian and Mississippian of Alberta, Saskatchewan, and North Dakota: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 4, p. 909-926, illus., table, 1969.

In the sedimentary basins of the northern United States and western Canada large amounts of rock, broadly described as evaporitic, are either petroleum-bearing or so situated in their geologic association with petroleum that evaporite geology bears directly on the petroleum occurrence. The evaporites are members of facies assigned to two distinct groups—a coastal-shoal/salt-flat suite and a reef/salt-basin suite, illustrated by Devonian and Mississippian examples. The reefs are not in stratigraphic-facies relation to the salt.—*from* Authors' abstract

01741 **Furlow, James W.** Geology of the Chatham County phosphate deposits [abs.]: Georgia Acad. Sci. Bull., v. 27, no. 2, p. 90, 1969.

07485 **Fye, Paul M.; Maxwell, Arthur E.; Emery, Kenneth O.; Ketchum, Bostwick H.** Ocean science and marine resources, [Chap. 1] *in* Uses of the seas—American Assembly, Columbia University: Englewood Cliffs, N. J., Prentice Hall, p. 17-68, illus., tables, 1968.

Physiographic, chemical and biological features of the ocean are summarized, and exploration history and developing research are reviewed briefly. In emphasizing marine resources, many other uses of the ocean are neglected; its continental shelves are most important, supplying all of its chemical and geological resources and 90

percent of its biological resources. Much more is known about their existence than about the means whereby they can be made useful to man. Problems of exploitation are difficult and tricky. In the tapping of wealth, largest increase is predicted in oil and gas, sand and gravel, desalinated water, aquaculture, and fish protein concentrates; more moderate, in phosphorite, manganese nodules, extracted chemicals, and natural harvest of food and fish. Solving legal and diplomatic problems in orderly and timely ways will permit cooperative and peaceful use of this wealth.—GDC

01710 **Fyson, W. K.** Profile variation in a kink set, *in* Research in tectonics: Canada Geol. Survey Paper 68-52, p. 243-254, illus.; discussion, p. 361, 1969.

Steep kink bands cross vertical foliation in slates and siltstones near Lunenberg, Nova Scotia. Rotated kink limbs are 0.25 to 47 inches long, and bands are 1 to 25 feet apart. The narrowest kink bands lie within wide bands near bounding surfaces, particularly where these diverge and kinks die out. The angular deviation of kinked foliation ranges from 15° to over 45°, and for individuals of variable width is greater the shorter the kinked limb. The longer, less rotated limbs increase both the offset and shortening across the kinks. The kinks initially propagated as narrow bands that, like refracted joints, tended to curve normal to competent layers. Where normal, further strain was accomplished by widening, but where oblique to foliation, there was continued internal rotation and bands remained comparatively narrow.—*from* Author's abstract

Gabrielse, H. *See* Mamet, B. L. 01972

Gagliano, Sherwood M. *See* Coleman, James M. 01688

Garner, L. E. *See* McGowen, J. H. 01620

01678 **Garrels, Robert M.; Mackenzie, Fred T.** Sediment distribution, differential sedimentary cycling, and geochemical "uniformitarianism" [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 718-719, 1969.

01883 **Garrett, R. G.; Nichol, Ian.** Factor analysis as an aid in the interpretation of regional geochemical stream sediment data, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 245-264, illus., tables, 1969.

Interpretation of regional geochemical survey data requires consideration of the effects of bedrock geochemistry, weathering, and other secondary factors tending to modify the bedrock-soil-stream sediment relationship. Where the relationship of the minor-element contents to the local environment is obscure, factor analysis can be used for identifying the dominant geochemical controls of the data. It is then possible to express the overall data in terms of these principal geochemical associations, thus providing a method for separating the minor-element variations related to different geochemical causes and hence permitting a more thorough interpretation. Factor analysis is used on data from a multi-element drainage reconnaissance over the Nimini Hills schist belt in Sierra Leone.—KAF

Gates, George L. *See* Manger, G. Edward. 01832

07406 **Gault, Donald E.; Quaide, William L.; Oberbeck, Verne R.** Impact cratering mechanics and structures, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 87-99, illus., 1968.

Three stages in the development of a crater are recognized: (1) an initial shock-wave compression of projectile and target, during which kinetic energy is transferred from impacting body to the ground; (2) an excavation stage, during which the crater is actually formed as the result of particle motions produced by the shock waves; and (3) a stage of post-cratering modification of the basic impact-basin by geologic processes.—*from* Authors' abstract

Gavish, Eliezer. *See* Allen, Robert C. 01825

Gebelein, Conrad D. *See* Neumann, A. Conrad. 01617

01826 **Gebelein, Conrad D.** Distribution, morphology, and accretion rate of recent subtidal algal stromatolites, Bermuda: Jour. Sed. Petrology, v. 39, no. 1, p. 49-69, illus., table, 1969.

Small head-shaped structures (biscuits) and large ellipsoidal structures (domes) form in the 3-25 feet zone by agglutination and binding of detrital sediment onto the filaments of blue-green algae. Algal stromatolites accrete at the rate of 1 lamina (sediment-rich layer plus algal-rich layer) per day. The distribution, abundance and morphology are controlled by current velocity and rates of sediment movement over the bottom. Algal mats occur in areas of less than 60-80 gm/hr/ft bottom sediment movement. Biscuits and domes are restricted to the range 8-60 gm/hr/ft bottom sediment movement. Domes form in areas of rapid sedimentation and biscuits in areas protected from high rates of sediment movement. Streamlining is related directly to current velocity and sediment movement. Elongated forms have the axis parallel to the current flow.—*from* Author's abstract

07373 **Germeraad, J. H; Hopping, C. A.; Muller, J.** Palynology of Tertiary sediments from tropical areas: Rev. Palaeobotany and Palynology, v. 6, nos. 3-4, p. 189-348, illus., tables, 1968.

Marker species can be classified into: a restricted number of pantropical marker species, a larger number of marker species which occurred in both the South American and west African regions, tropical today, and a still greater quantity of species which are of significance only within a single botanical province. These three systems of subzonation are compared with independent zoopaleontological time-stratigraphic correlation and discussed in great detail, with special emphasis upon Caribbean data. The major palynological changes marking the boundaries of the pantropical subzonation are thought to reflect evolution of new groups of plants. Climatic boundaries are next in importance, but in general they are more restricted to specific regions. Many species are described and illustrated.—*from* Authors' summary

07385 **Gibbons, A. B.** Geologic map of the Mays Lick quadrangle, Mason County, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-784, scale 1:24,000, section, text, 1968.

Argillaceous limestone suitable for manufacture of portland cement may be present in the Mays Lick quadrangle from the upper part of the Grant Lake Limestone. Construction materials for local use are obtained from all bedrock units, most commonly from the lower Grant Lake. Soft clay shale of the Kope Formation and the clayey soil above it are susceptible to slumping and sliding when wet and where the surface has been steepened. Lineaments plotted on the map are traces of open fractures or zones of such fractures in bedrock mainly in the Grant Lake Limestone; water moving down and along the fractures creates surface sinks and underground caverns, posing construction hazards.—MCM

07426 **Gibbs, G. V.; Prewitt, C. T.** Amphibole cation site disorder [abs.], *in* Internat. Mineralog. Assoc., 5th Gen. Mtg., Cambridge, England, 1966, Papers and Proc.: London, Mineralog. Soc., p. 334-335, 1968.

Gier, D. A. *See* Bidwell, O. W. 07437

Gigl, Paul. *See* Dachille, Frank. 07464

07427 **Gilbert, M. C.** Effect of pressure on the incongruent melting of acmite [abs.], *in* Internat. Mineralog. Assoc., 5th Gen. Mtg., Cambridge, England, 1966, Papers and Proc.: London, Mineralog. Soc., p. 335, 1968.

01845 **Gingerich, Philip D.** Markov analysis of cyclic alluvial sediments: Jour. Sed. Petrology, v. 39, no. 1, p. 330-332, 1969.

Statistical Markov chain analysis applied to vertical lithic transitions demonstrates cycles (average 30 feet thick) in Paleocene alluvial sediments of the Polecat Bench Formation in the northern Bighorn Basin, Wyoming. Subtracting the independent trials probability matrix from the transition probability matrix leaves a residual matrix of positive probabilities that define the fully developed cyclothem. The fully developed cyclothem for the Polecat Bench sequence is the succession sandstone-mudstone-limestone-mudstone-lignite.—Author's abstract

07352 **Ginsburg, Robert N.** The interaction of environments and sediments on Great Bahama Bank [abs.], *in* National symposium on ocean sciences and engineering of the Atlantic Shelf, Philadelphia, 1968, Trans.: Washington, D.C., Marine Technology Soc., p. 285-286, 1968.

07416 **Glaessner, M. F.** Biological events and the Precambrian time scale, *in* Geochronology of Precambrian stratified rocks—Internat. Conf., Edmonton, Alberta, 1967, Papers: Canadian Jour. Earth Sci., v. 5, no. 3, pt. 2, p. 585-590, illus., 1968.

For stratigraphic purposes, time scales are constructed on the basis of either geophysical and geochemical, or biological processes and events. Biological evolutionary processes provide the main markers linking the Phanerozoic time scale with fossiliferous rock sequences. Progress in the study of Precambrian fossils makes it necessary to asess present and future possibilities of their use as time markers and correlation indicators for the Precambrian. The low grade of diversification attained by organisms during the first one-half or two-thirds of Precambrian time may reduce the possibilities of biostratigraphic dating of early and middle Precambrian sediments to insignificance, but enough is known about late Precambrian plants and animals to suggest that careful investigation of their stratigraphic distribution and potential use as time markers will repay the effort.—Author's abstract

07472 **Gnirk, Paul F.** The relationship between crater formation with contained chemical explosions and the physical properties of taconite [abs.], *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 625, 1968.

07459 **Gold, D. P.** A study of quartz subfabrics from the Brent Crater, Ontario, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 495-508, illus., 1968.

Optic axis orientations were found to be random, but planar features (such as trains of fluid inclusions and deformation lamellae), microfractures, and extinction bands exhibited strongly preferred orientations, whose planes are approximately radial and concentric to the crater. Comparison of the angular relationships between a given planar feature and the optic axis of the host quartz grain with the theoretical isotropic fracture distribution curve for quartz indicates a crystallographic control over development of the planes. The broad coincidence of quartz subfabric elements to crater geometry suggests but does not prove an impact origin for the crater.—MS

Gold, D. P. *See* Aitken, F. K. 07463

Goldberg, Edward D. *See* Bernat, Michel. 02005

07480 **Goldich, S. S.** Geochronology in the Lake Superior region, *in* Geochronology of Precambrian stratified rocks—Internat. Conf., Edmonton, Alberta, 1967, Papers: Canadian Jour. Earth Sci., v. 5, no. 3, pt. 2, p. 715-724, illus., tables, 1968.

The oldest known rocks in the Lake Superior region are the granitic gneisses of the Minnesota River Valley dated at 3300 to 3550 m.y. Ages of metasedimentary formations in the region appear to be time of folding or of metamorphism rather than of deposition. The more serious problems in dating the rock, however, are geologic ones, such as effects of metamorphism and weathering on parent-daughter nuclide ratios. Both analytical and geologic considerations must enter into any time classification of the Precambrian. A three-fold division of the Precambrian with time

boundaries at 2600 and 1800 m.y. serves well for the Lake Superior region. In addition, Keweenawan igneous activity is well dated at about 1100 m.y. ago. Terms such as Keweenawan, Huronian, and others are best used locally; units that might have worldwide utility should not be tied closely to geographic localities.—*from* Author's abstract

01860 **Goldsmith, Louis H.** Concentration of potash salts in saline basins: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 4, p. 790-797, illus., 1969.

Processes of concentration of potassium salts probably begin after first precipitation of salt within an evaporite basin. As brine is concentrated, very complex solutions are formed which influence chemical and physical factors of concentration. Environmental and geologic processes further restrict locations for precipitation of potash. Upon complete evaporation of seawater and burial of salts, potash salts may be concentrated further and enriched by metasomatic processes. Salts now are precipitating on a reduced scale in limited areas along continental margins, inland seas, continental brine lakes, and salt pans. Trace minerals furnish much information on the genetic character. Argon, common where high concentration of potassium is present, can be used to determine the age of the salt.—*from* Author's abstract

Goreau, T. F. *See* Land, L. S. 01635

01648 **Gorsline, Donn S.** Geology of continental margins—Introduction and review [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 719-720, 1969.

01914 **Gosnell, Gary Johnston.** Three dimensional analysis of hinged end pile groups in a layered soil system [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2867B, 1969.

01649 **Gould, H. R.** Environmental indicators—A key to stratigraphic record [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 720, 1969.

01742 **Grant, Willard H.** Apatite weathering in the Panola Granite [abs.]: Georgia Acad. Sci. Bull., v. 27, no. 2, p. 90-91, 1969.

07481 **Green, D. C.; Baadsgaard, H.; Cumming, G. L.** Geochronology of the Yellowknife area, Northwest Territories, Canada, *in* Geochronology of Precambrian stratified rocks—Internat. Conf., Edmonton, Alberta, 1967, Papers: Canadian Jour. Earth Sci., v. 5, no. 3, pt. 2, p. 725-735, illus., tables, 1968.

New whole-rock Rb-Sr isochron data indicate that Archean greenstones of the Yellowknife area are 2625 ± 160 m.y. old. The folded sequence of volcanics and overlying sediments is intruded by two syntectonic to late tectonic batholiths (2610 ± 58 m.y. and 2590 ± 90 m.y.) and a large mass of muscovite granite 2575 ± 25 m.y. old. Low initial Sr-87/Sr-86 ratios suggest that late tectonic batholiths were unlikely to have formed by granitization of a great thickness of sediments beneath the greenstones. Since initial ratios of volcanics and intrusive rocks are similar, the basalt-dacite association is probably the early extrusive expression of the subcrustal process leading to formation of quartz diorite-granodiorite batholiths. The muscovite granite, however, may be from partial anatexis of newly derived sialic crustal segments.—*from* Authors' abstract

Green, Martha A. *See* Smith, James W. 01746

01713 **Greenberg, Richard J.; Brace, W. F.** Archie's law for rocks modeled by simple networks: Jour. Geophys. Research, v. 74, no. 8, p. 2099-2102, illus., 1969.

Simple two- and three-dimensional networks of electrical resistors, from which elements are eliminated in a random fashion, have electrical characteristics like those of brine-saturated rocks. The porosity-resistivity relation commonly observed for rocks and known as Archie's law was followed by these networks more or less independently of details of network geometry. Study of the networks suggests that under hydrostatic pressure crack population as well as crack size changes in typical rocks;

some cracks must become almost nonconducting in rocks under pressure.—Authors' abstract

01887 **Gregory, P.; Tooms, J. S.** Geochemical prospecting for kimberlites, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 265-305, illus., tables, 1969.

Results of work done near the Prairie Creek kimberlite pipe and American Mine in southwest Arkansas are presented. During soil formation there is a redistribution of the elements with a marked tendency for many of them to be concentrated in Fe-Mn nodules and(or) mineral aggregates. Anomalous halos have been detected in surface soils for several hundred feet downslope from kimberlite outcrops. Abnormal concentration of selected characteristic elements were also observed in drainage components for several thousand feet downstream from such outcrops. While basic and ultrabasic rocks, including kimberlite, can be detected by Ni analyses of stream sediments and soils, kimberlites can normally be differentiated by analysis of anomalies for Nb and other characteristic elements.—KAF

Griffiths, John C. *See* Ondrick, Charles W. 01834

Grimes, David J. *See* Akright, Robert L. 01884

Gryc, George. *See* Brosgé, William P. 01566

Haffty, Joseph. *See* Noble, Donald C. 01715

01918 **Haimson, Bezalel.** Hydraulic fracturing in porous and nonporous rock and its potential for determining in-situ stresses at great depth [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2925B, 1969.

Hall, John W. *See* Norton, Norman J. 01750

07403 **Hamilton, J. B.** Carbonate deposits in the Nauwigewauk, Elliott Road, and Torryburn areas, Kings County: New Brunswick Dept. Nat. Resources Mineral Resources Br. Rept. Inv. 8, 18 p., illus., tables, geol. map, 1968.

Economically significant quantities of limestone and dolomite occur in the Saint John area. It is estimated that in excess of 2.5 million tons of high-calcium limestone are present in the Nauwigewauk area of Kings County. Large reserves of limestone of somewhat lower grade are also present. In the Elliott Road area, at least 15 million tons of dolomite are present of average grade SiO_2-1.0 percent, $CaCO_3$-59.8 percent and $MgCO_3$-39.4 percent. Limestone of potential economic significance also occurs at Torryburn.—Author's abstract

07417 **Hamilton, J. B.; Sutherland, J. K.** Silica in New Brunswick: New Brunswick Dept. Nat. Resources Mineral Resources Br. Rept. Inv. 2, 43 p., illus., tables, 1968.

Geologic data on the extensive natural deposits of siliceous materials in New Brunswick, including quartzite, sandstone, sand and vein quartz, are summarized; most are impure, but a few, briefly described, may qualify as silica resources. Quartzite of potential economic significance occurs in Precambrian rocks of the Saint John and Grand Manan Island areas; that of lesser grade, Ordovician and Silurian, at Burnthill, Central Waterville and Dorrington Hill. Carboniferous quartzitic sandstones are near Bathurst and Moncton. Thick quartz veins are most prominent on the south coast of the province. Sand deposits along Northumberland Strait, too low grade for glass, might be used in refractories or metallurgical industries. Removal of the magnetic fraction reduces percentage of Fe_2O_3 to 0.01 in better quartzites; to 0.02 in quartzitic sandstones; and to 0.33 in the sands.—GDC

01979 **Han, Jerry; Simoneit, Bernd R.; Burlingame, A. L.; Calvin, Melvin.** Organic analysis on the Pueblito de Allende meteorite: Nature, v. 222, no. 5191, p. 364-365, illus., 1969.

Results are presented of an analysis for certain organic constituents in a sample of the meteorite, collected a week after its fall on February 8, 1969, near Pueblito de Allende, Chihuahua, Mexico. The organic matter found in the surface layer is of biological origin and cannot be other than terrestrial contamination. The speed with which this contamination was acquired and the diversity of material contained in the contamination make doubtful any interpretation of organic materials found in meteorites of unknown or long terrestrial history. Also, the need for the extreme precautions that are being taken to protect the returned lunar sample from contamination is made all the more clear.—DBV

01650 **Hanshaw, Bruce B.** Inorganic geochemistry of carbonate shelf rocks [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 720-721, 1969.

01864 **Hansuld, John A.** What is a geochemical analysis?—A panel discussion, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 5-26, 1969.

The main objective of the discussion is to demonstrate the numerous factors that should be considered in carrying out and interpreting geochemical analyses. Improved communication between the field geologist, chemist, and analyst is stressed.—KAF

01651 **Hardie, Lawrence A.** Algal crusts from Bahamas [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 721, 1969.

07453 **Hardin, George C., Jr.** The Louann Salt of the Gulf Coastal Region [abs.], *in* Forum on geology of industrial minerals, 4th, Austin, Tex., 1968, Proc.: Austin, Tex., Univ. Texas Bur. Econ. Geology, p. 67, 1968.

01718 **Harrington, John W.** The pre-natal roots of geology, a study in the history of ideas: Am. Jour. Sci., v. 267, no. 5, p. 592-597, 1969.

Knowledge of early geological observations comes down to us through imagery found in the surviving humanistic literature. Illustrations which predate the Huttonian renaissance of geology by two centuries are taken from the poetry of John Donne and Shakespeare. In the classical period Herodotus was the first great regional geologist. His work was predated by several centuries in the observational imagery of Homer and by at least a century with the regional geological cognition of the arid cycle by Second Isaiah. An adjunct to the study is obtained by relating the arid cycle geology of Second Isaiah and William Morris Davis in terms of the geographic path of Western intellectualism.—*from* Author's abstract

Harris, D. C. *See* Mandarino, J. A. 01996

Harris, D. C. *See* Petruk, W. 02011

02016 **Harris, D. C.; Thorpe, R. I.** New observations on matildite: Canadian Mineralogist, v. 9, pt. 5, p. 655-662, tables, 1969.

A study of matildite from another occurrence in the Camsell River area, N.W.T. is reported. The mineral occurs as pure irregular grains in a deposit containing native silver, native bismuth and Co-Ni arsenides and in which galena has not been identified. Single crystal studies and reflectivity measurements confirm the hexagonal symmetry postulated by Geller and Wernick, but with the *a*-cell dimension doubled, yielding values of $a = 8.12$; $c = 19.02$A. Electron-probe microanalysis shows that the mineral is homogeneous with a formula of $Ag_{0.95}Bi_{1.00}S_{1.97}$ which agrees very well with the ideal formula $AgBiS_2$. Microhardness values (25-gram load) range from VHN 59 to 76.—Authors' abstract

07435 **Harris, Stuart A.** Comments on the validity of the law of soil zonality [with French and German summ.], *in* Internat. Cong. Soil Sci., 9th, Adelaide, Australia, 1968, Trans., V. 4: New York, American Elsevier Publishing Co., p. 585-593, illus., table, 1968.

The concept of zonality, assuming climate as the dominating factor in classification of soils, ignores effects of other soil forming factors and fails to explain inversion of soil sequences; it cannot validly be regarded as a law. The more general concept suggested by Jenny (1941)—climate, parent materials, biological activity, topography and time all operating at once—fits far better the available evidence from the Americas and Europe. In examples presented here, climate alone has failed to control soil formation, parent materials are found to be of tremendous importance; climatic changes with time are imprinted on all but the youngest of soils, as on margins of glaciated areas in prairies of Kansas and southern Canada; erosion and deposition cause truncation or burial of pre-existing soils; changes in hydrology of an area being deeply cut by erosion result in other changes in soils.—GDC

Hart, S. R. *See* Steinhart, J. S. 01967

01852 **Hattersley-Smith, G.** Glacial features of Tanquary Fiord and adjoining areas of northern Ellesmere Island, N.W.T.: Jour. Glaciology, v. 8, no. 52, p. 23-50, illus., 1969.

Results of reconnaissance field work in northern Ellesmere Island since 1963 support the conclusion that the ice cover was once much more extensive than at present, although the age of maximum glaciation is not known. In the Tanquary Fiord area the conclusion is based on: bathymetric data indicating considerable overdeepening of the fiords; morphology of the main valleys; and the presence of moraines, erratics, and glacial lake deposits at high levels. Tanquary Fiord became free of ice at least 6,500 yr ago, as peat was forming in the valleys by this time. A long period of river erosion followed; within the last 4,000 yr, glaciers advanced to reoccupy V-shaped valleys and small ice caps regenerated. In the last 900 yr there has been little change in terminal positions of most major glaciers.—*from* Author's abstract

07448 **Hawkins, M. E.; Wood, S. O., Jr.** Resource and economic importance of Gulf Coastal salt deposits, *in* Forum on geology of industrial minerals, 4th, Austin, Tex., 1968, Proc.: Austin, Tex., Univ. Texas Bur. Econ. Geology, p. 7-22, illus., tables, 1968.

Gulf Coastal salt provided 16.6 million tons in 1966, about 45 percent of the United States total, and over 13 percent of the world output. Salt was mined from 23 domes in Alabama, Louisiana, and Texas by fresh-water solution or by room-and-pillar methods. The reserves in these 23 domes to a depth of two miles are 104 cu mi, or 517 billion tons. One hundred eight other inland domes offer good possibilities for salt extraction or underground storage areas for liquids. Twenty-three domes are being used to store liquid petroleum gases and can hold about 80 million bbls, about 57 percent of the United States capacity.—*from* Authors' abstract

Hay, William W. *See* Marszalek, Donald S. 01644

01652 **Hay, William W.; Cepek, Pavel.** Nannofossils, probability and biostratigraphic resolution [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 721, 1969.

01653 **Heckel, Philip H.** Recognition of shallow marine environments [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 721-722, 1969.

01654 **Hedberg, Hollis D.** Continental margins from viewpoint of petroleum geologist (keynote address)[abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 722, 1969.

Hedge, Carl E. *See* Noble, Donald C. 01715

Hedge, Carl E. *See* Doe, Bruce R. 01965

Hedge, Carl E. *See* Peterman, Zell E. 07486

07350 **Heezen, B. C.; Schneider, Eric D.** The shaping and sediment stratification of the continental rise [abs.], *in* National symposium on ocean sciences and engineering of the Atlantic Shelf, Philadelphia, 1968, Trans.: Washington, D.C., Marine Technology Soc., p. 279-280, 1968.

Heidel, S. G. *See* Thomas, Jolly D. 02025

02002 **Helsley, Charles E.; Steiner, Maureen B.** Evidence for long intervals of normal polarity during the Cretaceous Period: Earth and Planetary Sci. Letters, v. 5, no. 5, p. 325-332, illus., tables, 1969.

The polarity of all but two of 35 sites in North America is consistently normal, suggesting that the Cretaceous Period may be characterized by a magnetic field dominantly of one polarity. The published literature concerning Cretaceous rocks substantiates this hypothesis and indicates that reversals are present primarily in the Lower Cretaceous and the upper portion of the Upper Cretaceous Period. The longest period of constant normal polarity consistent with the data presently available is about 25 m.y. and is present in rocks from Upper Albian to Middle Santonian age. Magnetic anomaly patterns at sea show a smooth interval older than anomaly 32 (80 m.y. in age) which may correspond to this long period of normal polarity observed in Cretaceous rocks from North America.—*from* Authors' abstract

07360 **Hem, John D.** Graphical methods for study of dissolved aluminum complexes [with French abs.], *in* Geochemistry, precipitation, evaporation, soil-moisture, hydrometry—General Assembly of Bern, 1967, Repts. and Discussions: Internat. Assoc. Sci. Hydrology Pub. 78, p. 15-23, illus., 1968.

Distribution of ionic species in dilute solutions at 25°C and 1 atm pressure can be computed by mathematical procedures based on the law of mass action and related thermodynamic equations. Some knowledge of concentrations of ions and forms of complexes or ion-pairs, and their stability constants or free energies of formation are required. Accurate computations of amount and form of dissolved species of many constituents of natural water can be computed. Graphs can be prepared which give simple and direct insights into details of natural water chemistry. Examples show solubility of aluminum in relation to pH, dominant dissolved forms of aluminum in solutions containing various concentrations of fluoride, and proportions of uncomplexed to total dissolved aluminum in such solutions. Graphs show interrelated complexing effects of fluoride and sulfate, and fluoride and hydroxide.—*from* Author's abstract

01973 **Henriksen, Niels.** Geologisk kortlägning af Scoresby Sund området: Grönland 1969, no. 2, p. 33-46, illus., 1969.

Geological exploration of the Scoresby Sund area from 1822 to 1958 is reviewed briefly. A preliminary investigation of Nortvestfjord in 1967 was the first undertaking of a five-year project of Grönlands Geologiske Undersögelse. An exploration party on a polar ship with two helicopters in the summer of 1968 studied the geologic history, glaciation, volcanology, and sedimentation, preliminary to geologic mapping. It is believed that with modern expeditionary techniques it will be possible to accomplish more in this remote area without the scientific personnel being obliged to sacrifice a part of the working season to the many practical tasks and hardships typical of earlier exploration.—MCM

07356 **Henry, Harold R.** The effects of temperature and density gradients upon the movement of contaminants in saturated aquifers [with French abs.], *in* Geochemistry, precipitation, evaporation, soil-moisture, hydrometry—General Assembly of Bern, 1967, Repts. and Discussions: Internat. Assoc. Sci. Hydrology Pub. 78, p. 54-65, illus., 1968.

Experimental and analytical studies were made on a simplified geometric model. A horizontal, lateral temperature gradient was imposed upon a horizontal channel of square cross section containing sand saturated with water. Velocities were measured by tracing dye patterns along the glass walls and top of the channel. Temperatures were measured by networks of copper-constantan thermocouple junctions spaced throughout the channel. The experimental temperatures and velocities indicated the presence of a convection current which increased in strength as the temperature gradient increased. The effective value of thermal diffusivity is found to be about 50 times larger than the usual value because of the dispersion which occurs when the fluid moves through the tortuous channels within the porous bed.—*from* Author's abstract

01894 **Henyey, Thomas Louis.** Heat flow near major strike-slip faults in central and southern California [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2947B-2948B, 1969.

Heron, S. Duncan, Jr. *See* Swift, Donald J. P. 01956

01722 **Herz, Norman.** Anorthosite belts, continental drift, and the anorthosite event: Science, v. 164, no. 3882, p. 944-947, illus., table, 1969.

Most anorthosites lie in two principal belts when plotted on a predrift continental reconstruction. Anorthosite ages in the belts cluster around 1300 ± 200 m.y. and range from 1100 to 1700 m.y. This suggests that anorthosites are the product of a unique cataclysmic event or a thermal event that was normal only during the Earth's early history.—Author's abstract

01655 **Hester, Norman Curtis.** Depositional environment of an Upper Cretaceous deltaic sandstone in southeastern United States [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 722, 1969.

Heymann, Dieter. *See* Anders, Edward. 01723

High, L. R., Jr. *See* Ebanks, W. J., Jr. 01667

High, Lee R., Jr. *See* Picard, M. Dane. 01614

01656 **High, Lee R., Jr.; Picard, M. Dane.** Sedimentary cycles in Green River Formation (Eocene)—Modification of Walther's Law [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 722-723, 1969.

01960 **High, Lee R., Jr.** Storms and sedimentary processes along the northern British Honduras coast: Jour. Sed. Petrology, v. 39, no. 1, p. 235-245, illus., table, 1969.

Many abandoned tidal deltas occur along barrier ridges of the British Honduras coast. In these deltas, the seaward mouth of the tidal channel is blocked by the ridges, and thus the construction of the ridges represents an additional process to upset the balance of forces responsible for tidal deltas. Major storms are the cause. Scattered, newly formed beaches composed of soft, black, H_2S-rich mud occur in small bights along the coast. At Northern River Lagoon, the sequence, from top to bottom, of black mud, flotsam, and clean quartz sand, indicates that the beach did not accrete slowly, but formed during a single event. At Midwinter Lagoon a tidal channel open in 1944 is now blocked by a barrier formed in 1961 by a hurricane. The development of British Honduras coast can be understood only by considering both continuous and episodic events.—*from* Author's abstract

Higuchi, Hideo. *See* Nagasawa, Hiroshi. 02028

02042 **Himmelberg, G. R.; Papike, J. J.** Coexisting amphiboles from blueschist facies metamorphic rocks: Jour. Petrology, v. 10, no. 1, p. 102-114, illus., tables, 1969.

Coexisting sodic and calcic amphiboles from glaucophane schist samples from California and a metachert sample from New Caledonia were studied by electron microprobe and single crystal X-ray diffraction techniques to determine the chemical and crystallographic character of the associated amphiboles and the nature of the compositional gap. The data show a large range in composition of the calcic amphiboles and a restricted range of glaucophane composition, and indicate a significant solid solution of sodic amphibole components in the calcic amphibole phase and a decrease in *a* and *b* unit-cell parameters of the calcic amphiboles with increased content of the sodic component.—MS

01933 **Hirst, Terence John.** The influence of compositional factors on the stress-strain-time behavior of soils [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3305B-3306B, 1969.

Hite, Robert J. *See* Peterson, James A. 01857

07359 **Hoekstra, Pieter.** Moisture movement to a freezing front [with French abs.], *in* Geochemistry, precipitation, evaporation, soil-moisture, hydrometry—General Assembly of Bern, 1967, Repts. and Discussions: Internat. Assoc. Sci. Hydrology Pub. 78, p. 411-417, illus., 1968.

Moisture movement in an unsaturated clay, silt, and sand caused by freezing is studied in a laboratory soil column by the attenuation of gamma-radiation. The cumulative water transport from the unfrozen into the frozen part is directly proportional to the root of time. The boundary between frozen and unfrozen soil can be treated as a constant soil water tension boundary. Even with a very small temperature gradient in the unfrozen part, moisture migration from unfrozen into frozen soil occurs. Moisture movement in the unfrozen part of the column takes place under influence of a water content gradient. Moisture is redistributed in the frozen part by movement of water through the liquid-like transitional layer on the particle surface. The amount of moisture migration during freezing is of such magnitude that it is of importance in engineering and agriculture.—*from* Author's abstract

07444 **Hogberg, R. K.** Gravel deposits of the Minneapolis quadrangle, Minnesota, *in* Forum on geology of industrial minerals, 4th, Austin, Tex., 1968, Proc.: Austin, Tex., Univ. Texas Bur. Econ. Geology, p. 151-156, illus., 1968.

Braided outwash-fan bodies were formed near the leading edge of the Grantsburg moraines and in topographic lows within or on the flanks of the buried St. Croix Moraine. Crevasse bodies were deposited within fractures developed by tensional forces in the stagnating ice at the crest or on the lee slopes of the buried moraines. Gravel-bearing valley trains accumulated adjacent to the preglacial valley now occupied by the Minnesota River. Valley train bodies were formed by late Grantsburg meltwater rivers during the breaching of the St. Croix Moraine. In early postglacial time most river-terrace bodies were formed from the lagged gravels of eroded moraine. Pre-Grantsburg regolith was a source for a substantial amount of the gravel; events of late glacial and postglacial time had little effect on the deposits.—*from* Author's abstract

01853 **Holdsworth, G.** Primary transverse crevasses: Jour. Glaciology, v. 8, no. 52, p. 107-129, illus., tables, 1969.

From measurements of strain-rates on a temperate glacier (Kaskawulsh Glacier, Yukon) and on a polar glacier (Meserve Glacier, Antarctica), it is shown that where the curvature term is valid the theoretical value of strain-rate is in fair agreement with values measured on the surface of the two glaciers. It is also shown that the initial formation of crevasses is associated with local strain-rates of approximately the same magnitude as regional values. It was found that despite large differences in thermal, dimensional, and strain-rate parameters between the glaciers the crevasse depths and spacings are closely similar; the assumption that the strain on an intercrevasse block is negligible is not correct. "The direction of the principal extending strain-rate is, in most cases, perpendicular to the crevasse traces within 2° to 7°."—VSN

07351 **Hollister, Charles D.** Sediment texture and bottom currents on the continental shelf and slope off southeastern United States [abs.], *in* National symposium on ocean sciences and engineering of the Atlantic Shelf, Philadelphia, 1968, Trans.: Washington, D.C., Marine Technology Soc., p. 281, 1968.

Holmes, Charles W. *See* Berryhill, Henry L., Jr. 01700

Holmes, Mark L. *See* Echols, Ronald J. 01669

Holtan, H. N. *See* England, C. B. 01986

Hopping, C. A. *See* Germeraad, J. H. 07373

01888 **Horsnail, R. F.; Nichol, I.; Webb, J. S.** Influence of variations in secondary environment on the metal content of drainage sediments, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 307-322, illus., table, 1969.

A multi-element regional drainage sediment survey has revealed patterns of metal distribution more closely related to secondary environment, in particular to areas of high rainfall and poorly drained soils, than to either geology or mineralization. Such correlations are shown, to varying degrees, by Mn, Fe, Co, As, Ni, and Zn which are enhanced in the drainage sediments when compared with adjacent areas having similar geology but lower rainfall and freely drained soils. In contrast, Cr, Ga, Ti, and V show no variation with respect to the surface environment.—KAF

07496 **Horz, Friedrich.** Statistical measurements of deformation structures and refractive indices in experimentally shock loaded quartz, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 243-253, illus., 1968.

Shock features produced in quartz samples with three different crystallographic orientations include cleavages parallel to the unit rhombohedron or base and prism. The experimental results indicate that development of the cleavages involves a faulting mechanism. Development of planar features (including deformation lamellae) required pressures in excess of 100 kb. They cluster principally around the flat rhombohedrons and their orientation is independent of the direction of the propagating shock wave. The formation mechanism is not yet known. Breakdown of the quartz lattice, as reflected by changes in refractive indices and birefringence, begins at about 200 kb and occurs over a wide pressure range up to at least 300 kb.—MS

01977 **Hosman, R. L.** Geohydrology of the coastal plain aquifers of Arkansas: U.S. Geol. Survey Hydrol. Inv. Atlas HA-309, 1 sheet, tables, text, 1969.

The sheet contains inset maps showing altitude of the base of the fresh water and generalized geology, five block diagrams, a generalized geologic column, tabulated data on aquifer and pumping test results averaged by county, and a summary of hydrologic characteristics of principal aquifers. The Arkansas coastal plain is underlain by vast artesian aquifer systems, and most of the surface is blanketed by alluvial sands and gravels which contain water under both water-table and artesian conditions.—MCM

Howard, James D. *See* Mayou, Taylor V. 01646

01657 **Howard, James D.** Bottom sampling of Georgia estuaries with NEL spade corer [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 723, 1969.

01658 **Howard, James D.** Trace fossils as criteria for recognizing shorelines in stratigraphic record [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 723, 1969.

Howard, James D. *See* Pierce, J. W. 01829

01659 **Howe, Herbert J.** Significance of provincialism in Richmond (Upper Ordovician) correlations [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 723-724, 1969.

Howie, R. A. *See* Stephenson, D. A. 07429

01660 **Howie, Robert D.** Recent offshore developments, Atlantic coast of Canada [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 724, 1969.

02000 **Hubbard, Norman J.** A chemical comparison of oceanic ridge, Hawaiian tholeiitic and Hawaiian alkalic basalts: Earth and Planetary Sci. Letters, v. 5, no. 5, p. 346-352, illus., 1969.

The average compositions of Al_2O_3, TiO_2, and Zr are quite different for the two groups of basalts (oceanic ridge and Hawaiian) but extensive overlap also occurs. TiO_2 and Zr are inversely covariant with Al_2O_3 for oceanic ridge and Hawaiian basalts. The concentrations of Al_2O_3, TiO_2, and Zr in a wide range of basalt types are dependent upon the depth of magma segregation. The two basaltic groups are almost

completely different in the Sr concentration and REE abundance patterns. The concentrations of Sr and the REE abundance patterns are essentially independent of the concentration of Al_2O_3, TiO_2, and Zr. The Sr and REE data can be qualitatively explained by assuming varying degrees of partial melting to form the different liquids observed at the surface.—*from* Author's abstract

01568 **Hubert, John F.; Knewtson, Stephen L.** Dispersal patterns and diagenesis of oölitic calcarenites, Ste. Genevieve Limestone (Mississippian), Missouri [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 724, 1969.

01871 **Huff, L. C.** Accumulation of ore metals by mesquite plants [abs.], *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 510, 1969.

07363 **Humara Gómez, Gilberto.** Estudio geológico del extremo nor-oriental de la Sierra del Tunal, municipios de Cedral, S. L. P. y Dr. Arroyo, N. L.: Geología y Metalurgia, v. 4, no. 25, p. 7-29, illus., geol. map, 1968.

A geological survey was carried out of the extreme northeastern part of the Sierra de El Tunal, an area of about 900 sq km in the municipalities of Dr. Arroyo, Nuevo León, and of Cedral, San Luis Potosí, as a part of a series of investigations basic to hydrogeologic studies of this semidesert zone. The region is one of long ranges of gentle outline bordered by extensive alluvial plains. Rock formations exposed in the mountains are primarily Mesozoic and include Upper Jurassic limestones, calcareous phosphates, and lutites and Cretaceous limestones with chert, argillaceous limestones, marls, and lutites. Valleys and lowlands are mantled by Pleistocene gravels and Recent alluvium. Formations are described and cross sections are included with the geologic map.—VSN

Huppler, John D. *See* Morrow, Norman R. 01811

Hurley, P. M. *See* Fairbairn, H. W. 07479

Inden, Richard F. *See* Stieglitz, Ronald D. 01842

Ingram, Roy L. *See* Owen, Donald E. 01572

Innes, M. J. S. *See* Dence, M. R. 07503

01624 **Isphording, Wayne C.; Lodding, William.** Diagenesis and paleoclimatic significance of Alloway Clay [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 724, 1969.

01761 **Izett, G. A.; Scott, G. R.; Obradovich, J. D.** Oligocene rhyolite in the Denver basin, Colorado, *in* Geological Survey research 1969, Chap. B: U.S. Geol. Survey Prof. Paper 650-B, p. B12-B14, illus., 1969.

A rhyolite tuff formerly included in the Dawson Arkose of Late Cretaceous and Paleocene age is of early Oligocene age and constitutes a separate map unit. Biotite from the rhyolite has a potassium-argon age of 34.8 ± 1.1 m.y.—Authors' abstract

07434 **Jackson, M. L.** Weathering of primary and secondary minerals in soils [with French and German summ.], *in* Internat. Cong. Soil Sci., 9th, Adelaide, Australia, 1968, Trans., V. 4: New York, American Elsevier Publishing Co., p. 281-292, illus., tab 1968.

Susceptibility of minerals to depletion from soil under strong leaching and oxidation can be expressed by weathering indexes, as tabulated. With progressive desilication in open drained soils, sesquioxides accumulate as positive colloids on negative alumino-silicate surfaces, affecting soil cation exchange capacity and physical properties, then form free sesquioxide crystals and feralitic soils. Presence of mafic minerals, preconcentration of *Si* by evapotranspiration, and mobilization of sesquioxides prevent desilication of lithologic montmorillonite and cause build-up of

sialitic clays. Such chemical reactions represent retardation or reversal of leaching, involving matrix solution of soils; when its solute concentration is increased by overburden, seepage or other cause, weathering products may be completely different from those under normal leaching. Examples are given.—GDC

01625 **Jam L., Pedro; Dickey, Parke A.; Tryggvason, Eysteinn.** Subsurface temperatures in south Louisiana [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 724-725, 1969.

Jambor, J. L. *See* Sabina, Ann B. 02015

01966 **James, D. E.; Sacks, I. S.; Lazo, E.; Aparicio, P.** On locating local earthquakes using small station networks: Carnegie Inst. Washington Year Book 67, 1967-68, p. 344-353, 1969.

Jenkins, W. A., Jr. *See* Wermund, E. G. 01591

01626 **Jodry, Richard L.** Supratidal accumulation of reef detritus at Bonaire, Netherlands Antilles [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 725, 1969.

Johnson, Noye M. *See* Likens, Gene E. 02036

01898 **Jones, Norris William.** Crystal chemistry of the humite minerals [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 3016B, 1969.

01627 **Jones, Paul H.** Hydrology of deep sedimentary basins [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 725, 1969.

01946 **Jones, Paul Hastings.** Hydrology of Neogene deposits in the northern Gulf of Mexico basin [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3364B, 1969.

01978 **Jones, Robert S.; Fleischer, Michael.** Gold in minerals and the composition of native gold: U.S. Geol. Survey Circ. 612, 17 p., tables, 1969.

Gold occurs in nature mainly as the metal and as various alloys; it forms complete series of solid solutions with silver, copper, nickel, palladium, and platinum. In association with platinum metals, it occurs as free gold and in solid solution. Native elements contain the most gold, followed by sulfide minerals. Several gold tellurides are known, but no gold selenides, and gold is certainly combined with sulfur only in the telluride-sulfide mineral nagyagite. Nonmetallics carry the least and light-colored minerals less gold than dark. Some conclusions are conflicting as to the relation of fineness of native gold to its position laterally and vertically within a lode, nature of the country rocks, and location and size of nuggets in a streambed, as well as to variation of fineness within an individual nugget.—*from* Authors' abstract

01915 **Jongedyk, Howard Albert.** Some relations of electrokinetic phenomena to the hydraulic and electroosmotic permeability of uniform sands [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2868B-2869B, 1969.

Jordan, Dianne. *See* Beerbower, James R. 01695

01628 **Jordan, William M.** Enigma of Colorado Plateau eolian sandstone [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 725-726, 1969.

01909 **Judd, Robert William.** Pennsylvanian coal ball flora of Indiana [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2774B-2775B, 1969.

Kahn, J. S. *See* Braun, R. L. 01724

07473 **Kahn, J. S.; Nichols, M. C.; Taylor, R. W.** Observations on the energy distribution and the chemical, petrographic, and mineralogical effects of underground explosions [abs.], *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 625, 1968.

02014 **Karup-Möller, S.** Secondary violarite and bravoite, English Lake, Manitoba: Canadian Mineralogist, v. 9, pt. 5, p. 629-643, illus., 1969.

Supergene or hypogene alteration of a pentlandite-chalcopyrite-pyrite assemblage has resulted in the formation of a number of secondary sulfides. Violarite formed first and occurs pseudomorphically after pentlandite. Alteration later intensified, resulting in the dissolution of violarite, chalcopyrite and pyrite and the concomitant deposition of bravoite, idiomorphic pyrite, anhedral pyrite, marcasite, chalcopyrite, hematite, quartz and carbonate. Bravoite, in contrast to violarite, does not occur pseudomorphically after pentlandite. This relationship is considered to be of general application. The nickel content of each sulfide was determined using an electron microprobe analyzer. Relationships between idiomorphic pyrite and bravoite show that an immiscibility gap may exist between pyrite, with up to 1.5 percent Ni, and bravoite, with 11 to 12 percent Ni.—Author's abstract

07423 **Keester, Kenneth L.; White, William B.** Crystal-field spectra and chemical bonding in manganese minerals, *in* Internat. Mineralog. Assoc., 5th Gen. Mtg., Cambridge, England, 1966, Papers and Proc.: London, Mineralog. Soc., p. 22-35, illus., tables, 1968.

Optical absorption spectra, obtained on a suite of bivalent manganese minerals by transmission through single crystals or by diffuse powder reflection techniques, exhibit 5 to 7 weak absorption bands in the visible range that can be assigned in terms of the energy level diagram of Mn^{2+}. The manganese spectrum is most useful in that easily recognizable sharp bands due to ${}^6A_{1g}$ ${}^4A_{2g}$:${}^5E_g$(G) and ${}^6A_{1g}$ ${}^4A_{1g}$ ${}^4E_g$(D) transitions can be used to calculate exact values for Racah parameters B and C. Racah B-parameter is a possible measure of extent of covalent bonding in manganese-oxygen bonds. The Nephelauxetic ratio varies from 73 to 83 percent in the various silicates, and is less than its values in carbonate, sulphate, borate, phosphate, and oxide minerals, indicating a higher degree of covalent bonding in the silicates.—*from* Authors' abstract

01629 **Kelling, Gilbert; Stanley, Daniel J.** Neocurrent trends and structural control of sedimentation in Wilmington submarine canyon, eastern United States [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 726, 1969.

Kelling, Gilbert. *See* Stanley, Daniel J. 07376

07484 **Kennedy, J. M.; Edgerton, A. T.** Microwave radiometric sensing of soil moisture content, *in* Geochemistry, precipitation, evaporation, soil-moisture, hydrometry—General Assembly of Bern, 1967, Repts. and Discussions: Internat. Assoc. Sci. Hydrology Pub. 78, p. 418-429, illus., table, 1968.

Beach sand, unconsolidated tideland mud, playa sediments, and loam were investigated. Intensity of electromagnetic energy emitted depends on temperature and emissivity of the object, and frequency of observation. Emitted energy is the product of thermometric soil temperature and soil emissivity; reflected energy, the product of microwave sky temperature and material reflectivity. Dielectric properties are dependent on soil moisture content. Changes in dielectric constant result in major changes in emissivity and radiometric brightness temperature. Microwave temperature differences between saturated tidal mud and the ocean water covering it were about 20°K. Soils and sediments with 1-7 percent water were found to be 120°K warmer than saturated muds. The difference between playa sediments containing 12 and 30 percent moisture was 60°K. Microwave radiometric surveys can aid in many hydrologic investigations.—*from* Authors' abstract

01630 **Kepper, John.** Middle and early Late Cambrian algal biostromes and regional dolomitization in Great basin [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 726, 1969.

01631 **Kerr, S. Duff, Jr.** Algal-bearing carbonate reservoirs of Pennsylvanian age, west Texas and New Mexico [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 726-727, 1969.

Ketchum, Bostwick H. *See* Fye, Paul M. 07485

01924 **Ketner, Keith Brindley.** Ordovician siliceous sediments of the Cordilleran geosyncline [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2941B, 1969.

01934 **Khanna, Sat Dev.** An experimental investigation of turbulence due to forms of bed-roughness [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3306B, 1969.

07474 **King, Elbert A., Jr.** Recent information on the origin of tektites [abs.], *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 626, 1968.

02039 **King, Philip B.** (compiler). Tectonic map of North America: Washington, D.C., U.S. Geol. Survey, scale 1:5,000,000, 1969.

01806 **Kinsman, David J. J.** Modes of formation, sedimentary associations, and diagnostic features of shallow-water and supratidal evaporites: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 4, p. 830-840, illus., table, 1969.

The physiographic requirements of brine production are commonly in the form of lagoons, pans, and exposed supratidal surfaces. The most common environment is the exposed salt flat or sabkha, a fairly level, salt-encrusted surface that only occasionally is inundated. Sabkhas are equilibrium geomorphic surfaces, their levels being dictated by the local level of the ground water, which rarely exceeds a depth of 1-2 m. Sabkhas are formed where eolian sand supply is limited and where hard rock lies below the level of the water-table. Particularly significant are the high rates of shoreline regression in sabkha environments. Sabkha diagenesis involves interstitial emplacement of evaporite minerals within host sediments and changes in host sediments themselves. Coastal sabkhas show diachronism of diagenesis, the evaporite-mineral belts moving progressively seaward as depositional offlap proceeds.—*from* Author's abstract

01947 **Kirsch, Stephen Augustine.** Structure of the metamorphic and sedimentary rocks of Mineral Ridge, Esmeralda County, Nevada [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3364B-3365B, 1969.

01632 **Kissling, Don L.** Cycles in Gasperian (Mississippian) basin-edge sediments of Indiana [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 727, 1969.

Klein, George deVries. *See* Burger, John A. 01844

07379 **Klein, George deVries.** Intertidal zone sedimentation, Minas Basin north shore, Bay of Fundy, Nova Scotia, *in* National symposium on ocean sciences and engineering of the Atlantic Shelf, Philadelphia, 1968, Trans.: Washington, D.C., Marine Technology Soc., p. 91-107, illus., tables, 1968.

Major processes are wave-generated currents, waves, tidal currents, longshore drift, open channel flow, and suspension settlement. Major erosion occurs through wave action directed towards seacliffs of Silurian, Carboniferous, and Triassic bedrock, and Pleistocene sediment. A lag concentrate of marginal gravels develops at the base of the cliffs, which longshore drift reworks into a linear elongation of marginal gravel bars at an annual rate of four feet. Linear sandy gravel bars, normal to the shore, are deposited by bankful spillover in tidal channels and subsequent onshore reworking. Mud is derived by wave erosion on shore and transported seaward in suspension; it is deposited only during slack water at high tide. Linear sand bodies are deposited by tidal currents.—*from* Author's abstract

01807 **Klingspor, A. M.** Middle Devonian Muskeg evaporites of western Canada: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 4, p. 927-948, illus., 1969.

The Muskeg Formation is a complex of intricately interbedded and interfingering carbonate and evaporite rocks, with interspersed insoluble residual beds. The complex can be divided into several time-stratigraphic entities, which indicate a constant upward increase in salinity. The vertical succession is consistently repeated in the horizontal dimension as normal marine sediments grade into progressively more saline sediments of an interior barred basin. Supra- or intertidal deposits of

evaporites of the Muskeg Formation are believed to have been laid down from stratified brines filling the deepest part of the basin. The seaward position of a broad pre-evaporation shelf in northwestern Alberta was favored for prolific organic activity. Barrier, pinnacle, fringe, and patch reefs growing at shallow depth kept pace with subsidence.—*from* Author's abstract

Knewtson, Stephen L. *See* Hubert, John F. 01568

07387 **Knochenmus, Darwin D.** Surface drainage characteristics in Volusia County, Florida: Florida Div. Geology Map Ser., no. 30, scale about 1 in. to 7 mi., text, 1968.

Volusia County receives most of its ground water from recharge of local rainfall, and the piezometric surface is highest in the center of the county, farthest from areas of discharge along St. Johns River and the Atlantic Ocean. In many places the piezometric surface is less than five feet below the land surface—a potentially beneficial situation in obtaining a ground-water supply but a detrimental factor when draining swampy areas. Effective drainage of difficult-to-drain areas can be accomplished perhaps by pumping water from the underlying aquifer. The four maps on the sheet show drainage basins, average annual rainfall and runoff, piezometric surface relative to land surface, and drainage feasibility.—MCM

Knott, S. T. *See* Uchupi, Elazar. 01576

Knott, S. T. *See* Bowin, Carl O. 01703

Kodama, H. *See* Brydon, J. E. 07431

Koizumi, M. *See* Kume, S. 01721

01712 **Kornblum, Joseph J.** Micrometeoroid interaction with the atmosphere: Jour. Geophys. Research, v. 74, no. 8, p. 1893-1907, illus., tables, 1969.

This analysis is concerned primarily with determining the velocity and size history of stony meteorite particles (of initial radius $<50\mu$) in their passage through the atmosphere down to 55 km altitude. It is shown that the applicable terminal velocity is the kinetic terminal velocity and not the free molecular flow terminal velocity. Results are presented for various values of the similarity variable, entry radius $\times$ cos (entry angle).—DBV

01734 **Kornblum, Joseph J.** Concentration and collection of meteoric dust in the atmosphere: Jour. Geophys. Research, v. 74, no. 8, p. 1908-1919, illus., tables, 1969.

This paper determines the particle flux and space density histories of stony micrometeorite dust as functions of altitude when ablation is considered. From the ablation model, for a given entry flux, the size distribution and concentration to be expected after ablation can be calculated. It is such a distribution which is examined by rocket-borne, balloon-borne, and ground-based collectors. Also, for a given particle collection, the entry flux required to give that collection can be calculated. Consequently the ablation model is not in disagreement with any collection, as it makes no statements regarding the true entry flux to the Earth; it is the various collection experiments which are inconsistent with each other.—DBV

01633 **Kraft, John C.; Maisano, Marilyn D.** Stratigraphic correlation and reservoir distribution in Mid-Atlantic part of Atlantic coastal plain-continental shelf geosyncline [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 727, 1969.

07424 **Kretz, Ralph.** Growth of phlogopite crystals in marble from Quebec, *in* Internat. Mineralog. Assoc., 5th Gen. Mtg., Cambridge, England, 1966, Papers and Proc.: London, Mineralog. Soc., p. 85-93, illus., tables, 1968.

The edges of growth steps on certain phlogopite crystals may be straight, irregularly curved, or cuspate. Straight step edges may or may not be parallel to lines of closely packed oxygen ions in the mica structure. Chemical processes that have participated in the crystallization of phlogopite are considered.—Author's abstract

01634 **Krinsley, David H.** Recognition of pre-Pleistocene glacial environments [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 727, 1969.

Krinsley, David H. *See* Coch, Nicholas K. 01685

Krouse, H. Roy. *See* Lewis, John S. 02029

01721 **Kume, S.; Ueda, S.; Koizumi, M.** Synthesis and phase change of germanate albite under pressures: Jour. Geophys. Research, v. 74, no. 8, p. 2145-2147, table, 1969.

The synthesis of germanate albite and its behavior under pressure are reported briefly. The results of this study suggest that albite is transformed to the dense cryptomelane-type phase in the range of temperature and pressure in which stishovite exists stably.—DBV

01988 **Kummel, Bernhard.** Ammonoids of the Late Scythian (Lower Triassic): Harvard Univ. Mus. Comp. Zoology Bull., v. 137, no. 3, p. 311-702, illus., tables, 1969.

The ammonoid fauna, mostly ceratite, of the Late Scythian *Prohungarites* Zone consists of 65 genera and 154 species, here described; 42 genera are limited to the zone, 20 are known also in the older *Columbites* and *Owenites* Zones, two are known in the younger Anisian. Twenty-four genera are endemic to the Tethyan region; the western Pacific, eastern Pacific (western North America), and Arctic faunas have only two endemic genera each. The Tethyan region has 57 genera, the eastern and western Pacific have 25 each, the Arctic 15; a true faunal gradient reflecting a climatic pattern is suggested. The *Columbites* fauna, immediately below the *Prohungarites* and closely related to it, is well known in Idaho and Siberia, but is not known, as yet, in the Tethyan region.—VMJ

Kurasawa, Hajime. *See* Doe, Bruce R. 01965

01905 **Labib, Tarik Mohamed.** Pedogenic distribution of clay mineral species in soil profiles [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2708B, 1969.

07400 **Lagus, Peter L.; Anderson, Don L.** Tidal dissipation in the Earth and planets: Physics Earth and Planetary Interiors, v. 1, no. 7, p. 505-510, illus., tables, 1968.

The discrepancy between seismic and tidal effective Q values can be attributed to dissipation in the shallow seas; there is no need to invoke frequency or amplitude dependence. Present data do not allow an accurate determination for dissipation in the Earth's interior from tidal or astronomic data but bounds can be placed on this parameter. Most dissipation probably occurs in the high temperature-low pressure upper mantle. The main difference in the Q of the small and large planets can be attributed to the effect of pressure which suppresses dissipation in the larger planets.—*from* Authors' abstract

01755 **Lajtai, E. Z.** Brittle fracture in direct shear and the development of second order faults and tension gashes, *in* Research in tectonics: Canada Geol. Survey Paper 68-52, p. 96-112, illus. 1969.

The possible origin of second order shear fractures and tension gashes associated with first order or primary faults is examined from the static viewpoint. A static mechanism is developed which is based on the assumption that normal stresses acting on planes perpendicular to displacement are fully or partially relieved. Depending on the actual state of stress after faulting and the strength of rock against tensile or shear stresses, failure will be either by tension (tension gash) or shear (second order shear fractures).—Author's abstract

01719 **Lambert, I. B.; Robertson, J. K.; Wyllie, P. J.** Melting reactions in the system $KAlSi_3O_8$-SiO_2-H_2O to 18.5 kilobars: Am. Jour. Sci., v. 267, no. 5, p. 609-626, illus., tables, 1969.

Synthetic sanidine and a sanidine-natural quartz mixture were reacted with 30 to 40 percent water and the melting relations were determined to 18.5 kb. The divariant

melting intervals located for each sample, along with the results of previous studies in the system, provided good estimates of the position of the univariant curves for the two reactions $Or + V \leftrightharpoons L$, and $Or + Qz + V \rightleftharpoons L$. Muscovite was present in trace amounts in all runs, including those quenched from the conditions well above its maximum T stability limit, but it was not found enclosed in glass. Thus, the muscovite was deposited from the vapor phase. Schematic phase diagrams for the system indicate that muscovite would not be expected as a stable liquidus phase for mixtures on the join $KAlSi_3O_8$-SiO_2-H_2O at pressures less than 10 kb.—*from* Authors' abstract

Lambert, Paul Wayne. *See* Elston, Wolfgang E. 07500

LaMori, P. N. *See* Brace, W. F. 01729

01635 **Land, L. S.; Goreau, T. F.** Submarine lithification of Jamaican reefs [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 727-728, 1969.

07488 **Lanphere, Marvin A.** Geochronology of the Yavapai Series of central Arizona, *in* Geochronology of Precambrian stratified rocks—Internat. Conf., Edmonton, Alberta, 1967, Papers: Canadian Jour. Earth Sci., v. 5, no. 3, pt. 2, p. 757-762, illus., tables, 1968.

K-Ar mineral ages from a post-tectonic pluton give a minimum age of 1690 m.y. for deformation and metamorphism of the Precambrian Yavapai Series near Jerome, Ariz. Rb-Sr measurements of whole-rock samples of silicic metavolcanic rocks indicate an age of 1610 ± 85 m.y. for one locality of the Deception Rhyolite and an 'age' of 1640 ± 38 m.y. for a suite of samples from the Ash Creek Group. Samples of the Alder Group give ages of less than 1600 m.y., but since the data and field relations suggest that these samples have lost radiogenic strontium, this age is probably a minimum.—Author's abstract

01636 **LaPorte, Léo F.** Paleozoic carbonate facies of central Appalachian shelf [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 728, 1969.

07383 **Larochelle, A.** L'application de la statistique au paléomagnétisme (with English abs.]: Canada Geol. Survey Paper 68-59, 19 p., illus., tables, 1968.

Standard statistical methods are adapted to the processing of paleomagnetic data from expressions derived for estimating the angular standard deviation and variance of a unit length vector population. It is shown that these expressions are valid whenever most of the vectors in a sample diverge from their means by an angle smaller than $\pi/4$. The analog of a normal distribution for such a population is defined and an adaptation of the variance ratio method to the statistics of directions is described. A numerical example illustrates the application of these theoretical considerations to an actual set of data.—Author's abstract

01948 **Larsen, Margaret Kreider.** Geochemical relationships of Laramide intrusives of the Empire region, Colorado [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3365B, 1969.

07415 **Larsen, Ole; Möller, Jörgen.** Potassium-argon age studies in West Greenland, *in* Geochronology of Precambrian stratified rocks—Internat. Conf., Edmonton, Alberta, 1967, Papers: Canadian Jour. Earth Sci., v. 5, no. 3, pt. 2, p. 683-691, illus., tables, 1968; *reprinted as* Grönlands Geol. Undersögelse Misc. Paper 57, 1968.

Geochronological units have been established in West Greenland partly on the basis of 34 new K-Ar age determinations. Central West Greenland belongs to a single basement gneiss unit more than 2700 m.y. old. Blocks of basement rocks are traversed by rectilinear shear zones tens of kilometers long and several kilometers wide; in these zones relic slices of supracrustal rocks occur within reworked basement gneisses with K-Ar ages of 2500-2700 m.y. Ages close to 1800 m.y. are found locally. North and south of the old basement younger orogenic rocks are found: the Nagssutôquidian fold belt in northern West Greenland, dated at 1700 to 1750 m.y., and the Ketilidian fold belt in South Greenland with late- to post-kinematic granites

1500 to 1600 m.y. old. Gardar nonorogenic igneous activity, 1000-1300 m.y., is only in South Greenland.—*from* Authors' abstract

01992 **Lawrence, D. E.** A wide field technique for viewing rock textures: Canadian Mineralogist, v. 9, pt. 5, p. 716-717, illus., 1969.

By manipulation of its optical components the low power magnification range of the petrographic microscope may be extended. The technique described allows a five to ten times increase in the diameter of the field of view, an aid to the interpretation of small scale structures and coarse textures in petrographic thin sections.—Author's abstract

01827 **Lawson, R. I.; Day, G. F.** Note on a non-laminated joint-free sample splitter: Jour. Sed. Petrology, v. 39, no. 1, p. 373-375, illus., 1969.

The chutes, support, and base of this sample splitter are milled in one series of cutting operations from a solid cube of metal. Receiving and dispensing pans are identical and interchangeable. Rigidity and freedom from contamination results from the absence of joints, flats, and sharp corners.—Authors' abstract

Lazo, E. *See* James, D. E. 01966

01637 **Lea, Graham.** Markov forecasting techniques in exploration [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 728, 1969.

Leisman, Gilbert A. *See* Schlanker, Charles M. 01974

01638 **Lewis, James O.** Practical computer usage for subsurface geologists [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 728-729, 1969.

02029 **Lewis, John S.; Krouse, H. Roy.** Isotopic composition of sulfur and sulfate produced by the oxidation of FeS: Earth and Planetary Sci. Letters, v. 5, no. 6, p. 425-428, illus., table, 1969.

Sulfate enriched in S-32 with respect to co-existent sulfur is found in the Orgeuil meteorite. Similar isotopic distributions can be effected with at least three laboratory procedures: (1) oxidation of FeS by traces of strong oxidizing agent such as O_2 or HOOH in a generally reducing aqueous environment, (2) bacterial oxidation of sulfides, or (3) reaction of elemental sulfur with water followed by partial oxidation of the unequilibrated products. For many reasons, the first mechanism is attractive for explaining the S-32/S-34 distribution in the carbonaceous chondrites.—Authors' abstract

01938 **Lewis, Standley Eugene.** Fossil insects of the Latah Formation (Miocene) of eastern Washington and northern Idaho [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3351B, 1969.

02036 **Likens, Gene E.; Johnson, Noye M.** Measurement and analysis of the annual heat budget for the sediments in two Wisconsin lakes: Limnology and Oceanography, v. 14, no. 1, p. 115-135, illus., tables, 1969.

Temperatures were measured five times, fall 1965 to fall 1966, in water, sediments to 8 m below interface, and surrounding bog sediments of Stewart's Dark Lake and Tub Lake in northwestern Wisconsin. Otherwise similar, the lakes are meromictic and holomictic, respectively, in circulation. Seasonal changes in isotherm patterns are similar for both lakes, showing predominance of solar energy in the overall heat budget; geothermal heat is a significant source only in the deepest part of Stewart's Dark Lake. A negative steady-state thermal gradient is associated with the shoreline; the gradient is positive lakeward and landward, thus each lake has a relatively warm rim. The mean annual budget for sediments of Stewart's Dark Lake was 730 cal per cm^2, for Tub Lake 970 cal per cm^2—about 10 and 12 percent of the annual heat budgets for the water in each lake.—VMJ

01987 **Lillegraven, Jason A.** Latest Cretaceous mammals of upper part of Edmonton Formation of Alberta, Canada, and review of marsupial-placental dichotomy in mammalian evolution: Kansas Univ. Paleont. Contr., art. 50, Vertebrata 12, 122 p., illus., tables, 1969.

Multituberculate, marsupial, and placental mammals are described in detail from the Edmonton Formation northeast of Calgary. Comparison with other assemblages suggests that the Edmonton was deposited at the beginning of the taxonomic radiation of placental mammals, which had invaded North America from Asia in two basal stocks: the leptictid insectivores in Campanian or earlier, the papaeoryctid deltatheridians in late Campanian or early Maestrichtian. Most lineages of Cretaceous marsupials, probably of North American origin, became extinct shortly thereafter. A comparative analysis of the urogenital system and of early embryonic development among amniote vertebrates suggests that marsupials are less specialized than previously thought, and probably are rather close to the Early Cretaceous ancestral therian.—VMJ

Lilley, E. M. *See* Stephens, D. R. 07413

01639 **Lindholm, Roy C.** Detrital dolomite in Onondaga Limestone (Middle Devonian) of New York—Implications to "Dolomite question" [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 729, 1969.

01812 **Lindholm, Roy C.** Carbonate petrology of the Onondaga Limestone (Middle Devonian), New York—A case for calcisiltite: Jour. Sed. Petrology, v. 39, no. 1, p. 268-275, illus., tables, 1969.

The fine-grained carbonate portion of this formation has a mean grain size between 5 and 15 microns. Further, it is poorly sorted, contains numerous elongate particles, and is associated with ferruginous silt. These attributes are opposed to those ascribed to "microspar", but are characteristic of mechanically deposited carbonate silt. Calcisiltite is the most appropriate name for such material. Studies of Recent carbonates show that the comminution of the carbonate skeletal material yields silt-sized carbonate sediment. Abundant fossil debris in the Onondaga shows that such a mechanism could account for the calcisiltite. Most of the calcisiltite is burrowed, and such activity was probably a factor in the disintegration of the shell debris.—*from* Author's abstract

02040 **Lindsey, Alton A.; Schmelz, Damian V.; Nichols, Stanley A.** Natural areas in Indiana and their preservation—Report of the Indiana Natural Areas Survey: Lafayette, Ind., Purdue Univ., Dept. Biol. Sci., 594 p., illus., tables, 1969.

Natural areas here described are recommended for registration as nature preserves in the state preserves system, to be administered by the new Division of Nature Preserves under the Indiana Department of Natural Resources. Priority ratings nos. 1 (topmost) through 4 are assigned to 154 recommended areas, mostly small, which are categorized according to primary interest and potential as: scientific (specified as geological, aquatic biological, and terrestrial biological), perceptive-recreational, educational and school, scenic-aesthetic. The areas are grouped under eight major divisions of the state based mainly on physiography and vegetation; vegetation, particularly forests, and geologic and geomorphic features are also emphasized in the individual descriptions.—VMJ

07428 **Lindsley, D. H.** The join hedenbergite-ferrosilite [illegible] high pressures and temperatures [abs.], *in* Internat. Mineralog. Assoc., 5th [illegible]tg., Cambridge, England, 1966, Papers and Proc.: London, Mineralog. Soc., p. [illegible]6, 1968.

Lindsley, Nancy C. *See* Beck, Myrl E., Jr. 01731

Lipman, Peter W. *See* Doe, Bruce R. 01965

07465 **Lipschutz, M. E.** Shock effects in iron meteorites—A review, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 571-583, illus., 1968.

This paper is intended primarily to review the results of studies on iron meteorites which have been shocked naturally and artificially in the pressure range of 0 to >1000 kb. The nature of the alterations induced directly (by the pressure wave) and indirectly (by the shock-associated high temperatures) is discussed. The utility of these alterations in assessing the pressure-temperature history of some meteorites is also described.—*from* Author's abstract

07460 **Livingston, Donald E.; Damon, Paul E.** The ages of stratified Precambrian rock sequences in central Arizona and northern Sonora, *in* Geochronology of Precambrian stratified rocks—Internat. Conf., Edmonton, Alberta, 1967, Papers: Canadian Jour. Earth Sci., v. 5, no. 3, pt. 2, p. 763-772, illus., 1968.

Isotopic dating of stratified Precambrian rocks from twelve localities in Arizona and Sonora indicates formation from 1800 to 950 m.y. ago; oldest rocks are metamorphosed volcanics and sediments separated in time from a younger similar sequence by batholithic plutonism at about 1700 m.y. The second period of volcanism and sedimentation was terminated by batholithic plutonism about 1400 m.y. ago. Subsequent to 1400 m.y., the Apache Group, and probably the Grand Canyon Series, were deposited; their age is greater than the 1150 m.y. old sills and dikes intruding them. Some areas not underlain by the Apache Group were metamorphosed and intruded by silicic plutons about 1000 m.y. ago.—*from* Authors' abstract

01980 **Lliboutry, L. A.** How ice sheets move: Sci. Jour., v. 5, no. 4, p. 50-55, illus., 1969.

From results of detailed studies in Greenland and some in Antarctica by various expeditions, Lliboutry has suggested that no sliding of ice can occur on bedrock if there is no temperate layer; ice must be at the melting point. However, if no temperate layer is present and if cold ice is in contact with bedrock, the basal temperature can rise irreversibly to the melting point by a feedback process: a larger strain rate produces more heat which then warms the ice and further increases the strain rate. Thus, this theory infers that ice currents may appear suddenly in a cold ice sheet while the ice is flowing towards the coast. This explains the abnormally high velocities that have been measured in various places and suggests that an ice sheet does not flow in parallel vertical planes as previously assumed.—VSN

Lodding, William. *See* Isphording, Wayne C. 01624

01640 **Lohrengel, C. Frederick, 2d.** Palynology of Kaiparowits Formation, Garfield County, Utah [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 729, 1969.

Long, Laddie F. *See* Zimmerman, James B. 01581

01641 **Lucia, F. J.** Recognition of evaporite-carbonate shoreline sedimentation [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 729-730, 1969.

01976 **Lustig, Lawrence K.** Trend-surface analysis of the Basin and Range province, and some geomorphic implications: U.S. Geol. Survey Prof. Paper 500-D, p. D1-D70, illus., table, 1969.

Regional topographic variations in the Basin and Range province are examined quantitatively on the basis of 11 topographic parameters, using four analytical methods—manual contouring, relative-entropy function, Fourier analysis, and trend-surface analysis. The last was used to analyze topographic data; trend-surface maps of first, second, and third degree are presented for each parameter. Results suggest four geomorphic implications: there are three topographically distinct areas in the province; the topography reflects different erosional histories of the ranges and, hence different relief ages; the known distributions of fans and pediments accord well with the topographic distinction made here; and regional drainage distinctions that are compatible with the topographic, relief age, and fan-pediment distinctions must also exist because each is a function of time.—VSN

01878 **Lyon, Stephen Reed.** Phase reactions in the systems MgO-SiO_2-MgF_2, MgO-GeO_2-MgF_2, and MgO-GeO_2-$Mg(OH)_2$ [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3421B, 1969.

01642 **Maberry, John O.** Paleoecologic aspects of trace fossils [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 730, 1969.

01881 **Macdonald, John A.** An orientation study of the uranium distribution in lake waters, Beaverlodge district, Saskatchewan, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 357-376, illus., tables, 1969.

An orientation survey was conducted in the Beaverlodge uranium district to evaluate surface water sampling as a method of delineating regions of epigenetic pitchblende mineralization. Study of 13 control lakes indicates that, with the exception of the spring break-up period, there is no significant variation in the U content of lake water which can be attributed to seasonal temperature changes or precipitation. Seasonal changes in pH and bicarbonate content do not affect the solubility of U. There is an increase in the specific conductance of lake water in the vicinity of mineralized areas. Lake water assays show that the Beaverlodge uranium district is delineated by an analytical plateau of 0.9 ppb U_3O_8, approximately twice the regional background value. Numerous peaks within this analytical plateau define zones of pitchblende mineralization.—KAF

Mackenzie, Fred T. *See* Garrels, Robert M. 01678

02033 **Mackereth, F. J. H.** A short core sampler for subaqueous deposits: Limnology and Oceanography, v. 14, no. 1, p. 145-151, illus., 1969.

A pneumatically driven core sampler has been designed to obtain a core of undisturbed soft lake sediments 1 m long and 5 cm diameter, and to include a few centimeters of water at the top so that the position of the sediment-water interface can be determined accurately. This corer is complementary to a larger pneumatic corer (Mackereth, 1958) that takes 6-m long cores which, however, show considerable disturbance of orientation of the very soft sediments at the top of the core. The apparatus is lowered by hand from an anchored boat; a convenient feature of the small corer is a self-embedding anchor chamber with ball valves. Also described is an apparatus for completely controlled removal of the core; sections can be cut from the core as it emerges from the top of the core tube.—VMJ

Maclay, R. W. *See* Winter, T. C. 01961

01869 **MacLiver, C. N.; McDonald, D.; Sampey, D.; Sullivan, J. V.** Multi-element analysis in geochemistry—A six-channel atomic absorption spectrophotometer [abs.], *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 511, 1969.

01643 **MacQueen, R. W.** Upper Devonian and Lower Mississippian sedimentary record, western Canada shelf [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 730, 1969.

MacRae, N. *See* Fleet, M. E. 01995

Maggio, Carlos M. *See* Bebout, Don G. 01698

Maisano, Marilyn D. *See* Kraft, John C. 01633

02034 **Maitland, Peter S.** A simple corer for sampling sand and finer sediments in shallow water: Limnology and Oceanography, v. 14, no. 1, p. 151-156, illus., tables, 1969.

A simple hand corer has been proven practical for quantitative sampling of sand and finer sediments in water shallower than 5 meters, especially where vertical distribution of sediments or benthonic invertebrates is being studied. A replaceable clear plastic coring tube about 30 cm long (or any desired length), 7 cm inside diameter, with leading edge sharpened inside and outside, fits into a stainless steel corer head with watertight seal; the head screws into a steel driving pipe that has two gripping arms near the top for forcing the corer into the substrate. Water moves up the pipe and out the top; when no more water appears, a stoper is inserted in the top and the

corer is withdrawn. A spring valve at the side of the core tube allows controlled release of the core sample. A "depth disk" attachment controls depth of penetration.—VMJ

01993 **Majmundar, H. H.** Ramsdellite and groutite from Nova Scotia: Canadian Mineralogist, v. 9, pt. 5, p. 718-720, tables, 1969.

The ramsdellite comes from Cape Split, Kings County, and the groutite from the Walton mine, Hants County. The latter is the first reported from Nova Scotia. The complex paragenesis of minerals in the Walton area is reviewed, and X-ray diffraction data, comparison of unit cell dimensions, and trace-element determinations are tabulated.—ESL

01901 **Mallory, Bobby Franklin.** Paleoecologic study of a brachiopod fauna from the Cerro Gordo Member of the Lime Creek Formation (U. Devonian), north-central Iowa [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 3019B-3020B, 1969.

01972 **Mamet, B. L.; Gabrielse, H.** Foraminiferal zonation and stratigraphy of the type section of the Nizi Formation (Carboniferous System, Chesteran Stage), British Columbia: Canada Geol. Survey Paper 69-16, 19 p., illus., tables, 1969.

The type section of the Nizi Formation in northernmost central British Columbia comprises more than 1,643 feet of well-bedded carbonates with a conglomeratic clastic unit near the base. An abundant microfauna defines four assemblage-zones ranging in age from Late Visean to Early Namurian (zone 16 to 18 in Eurasia), an interval considered time-equivalent to the Chester Group (Upper Mississippian) of the midcontinent.—Authors' abstract

Mamet, B. L. *See* Toomey, Donald Francis. 01989

01996 **Mandarino, J. A.; Harris, D. C.** Epididymite from Mont St. Hilaire, Quebec: Canadian Mineralogist, v. 9, pt. 5, p. 706-709, table, 1969.

Two types of epididymites have been found at Mont St. Hilaire. The first consists of euhedral crystals which are tapering pseudo-hexagonal prisms, most only a few millimeters long; all have a soft grayish-brown covering. The second type consists of radiating groups of translucent to transparent lath-shaped crystals, elongated parallel to the *b*-axis. X-ray powder diffraction data are tabulated.—ESL

01832 **Manger, G. Edward; Cadigan, Robert A.; Gates, George L.** Irmay's saturation factor as an indication of an immobile fraction of pore water in saturated permeable sandstone: Jour. Sed. Petrology, v. 39, no. 1, p. 12-17, illus., table, 1969.

The permeability of moderately permeable Jurassic sandstone from the Colorado Plateau as calculated from grain size and other textural parameters agrees reasonably well with that determined experimentally, if calculated permeability is reduced by a factor that reflects saturation with capillary water. This result tends to confirm a conclusion by Irmay that in saturated permeable media a fraction of pore water is shut off from flow of water. Applicability of a saturation factor to poorly permeable sandstone is obscured where acid-soluble contents are high; apparent inapplicability results at very fine grain size perhaps because calculated permeability is not valid where based on very fine grained diameter.—Authors' abstract

01994 **Manning, P. G.** Optical absorption studies of grossularite, andradite (var. colophonite) and uvarovite: Canadian Mineralogist, v. 9, pt. 5, p. 723-729, illus., table, 1969.

The spectra of one colophonite, two grossularites, and one uvarovite are reported. Identification of the band marking electronic transitions to the second field-independent state in octahedrally-bonded Fe^3 was the purpose of the study.—ESL

01998 **Manning, P. G.** An optical absorption study of the origin of colour and pleochroism in pink and brown tourmalines: Canadian Mineralogist, v. 9, pt. 5, p. 678-690, illus., table, 1969.

Simple ligand-field theory is used in assigning absorption bands of polarized tourmaline spectra to specific transition-metal ions in specific environments. The pleochroic properties of the bands are correlated with some structural properties of the crystal. It is suggested that the colour of pink and brown tourmalines is due to *d-d* electronic transitions in octahedrally-bonded Mn^{3+} and Ti ions, respectively. Pink tourmalines have an absorption band at 19,000 cm^{-1} (520 mμ) and brown tourmalines at 22,000 cm^{-1} (450 mμ). The bands in both systems have maximum intensity when the electric vector of incident light is vibrating in the 001 plane; the probable causes of the pleochroism are discussed. It is also concluded that the transition metal ions are located mainly in the trigonal brucite units.—*from* Author's abstract

Marsh, Phyllis S. *See* Stearns, Richard G. 07502

01644 **Marszalek, Donald S.; Wright, Ramil C.; Hay, William W.** Foraminiferal test as an environmental buffer [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 730, 1969.

01645 **Masters, Charles D.** Environmental interpretation of upper part of Mesaverde Formation, northwestern Colorado, from outcrop, core, and subsurface study [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 730-731, 1969.

Maxwell, Arthur E. *See* Fye, Paul M. 07485

01646 **Mayou, Taylor V.; Howard, James D.** Recognizing estuarine and tidal creek sandbars by biogenic sedimentary structures [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 731, 1969.

07456 **McAnulty, W. N., Sr.** Geological exploration with a major chemical company, *in* Forum on geology of industrial minerals, 4th, Austin, Tex., 1968, Proc.: Austin, Tex., Univ. Texas Bur. Econ. Geology, p. 91-94, 1968.

The major chemical companies are well equipped to conduct geological exploration and several of them have many successful projects. There are advantages and disadvantages for geologists working for a major chemical company. Among the advantages are: (1) companies are strongly research-minded, (2) they have excellent analytical facilities, and (3) their various research departments provide expertise in basic and applied sciences and technology. Disadvantages are: (1) narrow scope of geological interest, insofar as exploration goes, (2) general lack of knowledge and understanding of geology, and (3) their economic evaluation practices are generally not applicable to geological projects. The major chemical companies will have increasing need for well-trained, energetic, and imaginative geologists.—*from* Author's abstract

01569 **McCaleb, J. A.; Wayhan, D. A.** Geological reservoir analysis, Madison Formation, Elk Basin field, Wyoming-Montana [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 731, 1969.

01717 **McCave, I. N.** Correlation using a sedimentological model of part of the Hamilton Group (Middle Devonian), New York State: Am. Jour. Sci., v. 267, no. 5, p. 567-591, illus., table, 1969.

The Cooksburg Sandstone Member of the Moscow Formation is proposed and divided into six informal units. It records a transgression in which there were two phases of sea-level rise, an initial slow one (I) followed by a rapid rise (II), occupying a brief interval in the Catskill depositional regression. A bar developed near the end of the cycle and the Portland Point Limestone developed seaward of the barrier when terrigenous material was trapped. Two models for the correlation of the Cooksburg with the Portland Point are described. The correlation of the Cooksburg with the Catskill redbeds is presented, and their sedimentologic relationship discussed.—HRC

McConnell, Duncan. *See* Fisher, D. Jerome. 01764

07386 **McCoy, H. J.; Sherwood, C. B.** Water in Broward County, Florida: Florida Div. Geology Map Ser., no. 29, scale 1:20,000, text, 1968.

Most water supplies in Broward County are obtained from the Biscayne aquifer which extends from the surface to depths of more than 200 feet near the coast and thins out near the surface 25-40 mi westward in the Everglades. Wells tapping thick limestone in the deep part commonly yield more than 1,000 gpm. Natural problems of flood and drought are caused by extreme variations in rainfall. Man-made problems include: sea-water intrusion resulting from over drainage, obtaining adequate supplies for the mushrooming population, and waste disposal. Application of comprehensive water-management policies and careful planning of changes within the flow system based on continuing hydrologic studies are needed.—MCM

01619 **McCoy, Scott, Jr.** Variations in Late Pennsylvanian molluscan faunas [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 731, 1969.

McDonald, D. *See* MacLiver, C. N. 01869

01830 **McDougall, David J.** Discussion of a note by J. M. Waite entitled "Anomalies in the thermoluminescence of the Austin Chalk of Texas" [1968]: Jour. Sed. Petrology, v. 39, no. 1, p. 395, 1969.

The writer has data to show that strain-induced thermoluminescence may increase rather markedly in the vicinity of faults, and completely overshadow any effects due to trace elements. In some cases, strain-induced thermoluminescence can be detected at distances in excess of 1000 feet from fault zones. Waite (ibid., v. 38, p. 253, 1968) noted this change near the Balcones fault zone and attributed it to ion impurity differences.—HRC

01925 **McDowell, Robert Carter.** Structural geology of the Macks Mountain area, Virginia [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2942B, 1969.

01620 **McGowen, J. H.; Garner, L. E.** Comparison of recent and ancient coarse-grained point bars [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 731-732, 1969.

07445 **McGowen, J. H.** Utilization of depositional models in exploration for nonmetallic minerals, *in* Forum on geology of industrial minerals, 4th, Austin, Tex., 1968, Proc.: Austin, Tex., Univ. Texas Bur. Econ. Geology, p. 157-174, illus., 1968.

The lower Wilcox fluvial system of the Eocene of the Coastal Plain of Texas consists of three distinct contemporaneous facies. Elongate lignite deposits are found in two; downdip, lignite was deposited in marshes and swamps on the delta plain. The quality of the lignite is different in the two systems. Ceramic clays with high kaolin content are common to all three Wilcox fluvial facies. One is characterized by widespread sand-kaolin, and in the other two, high kaolin clays occur commonly with channel sands. The Cretaceous Edwards limestone is a platform carbonate with facies analogous to those in the Bahamas. Four broad facies are: basinal, reef-grainstone, lagoonal, and platform. The reef-lagoonal couple controlled both initial carbonate deposition and subsequent diagenetic processes which produced two distinct dolomite facies.—*from* Author's abstract

07398 **McGrain, Preston.** Economic geology of Calloway County, Kentucky: Kentucky Geol. Survey, ser. 10, County Rept. 2, 35 p., illus., tables, geol. map, 1968.

Sand, gravel, limestone, ceramic clay, fuller's earth, and ground water are the principal geologic resources of Calloway County. Adequate reserves to develop new or expanded operations in most of these commodities are indicated. As the area experiences population and industrial growth, mineral-resources development should become increasingly important to the County. Rail and highway transportation facilities are availble. The proximity of water transportation could increase the radius of economical movement of unprocessed bulk material if barge-loading facilities were present. Maps showing clay, limestone, gravel and industrial sand resources of the County are in pocket.—Author's abstract

07372 **McGregor, Bonnie A.** Features at the Sohm Abyssal Plain terminus: Marine Geology, v. 6, no. 5, p. 401-414, illus., 1968.

Bathymetry and magnetic anomalies reflect the complexity of structure at the southern extension of Sohm Abyssal Plain between 29°-27° N., 55°-52° W. General structural trend is N. 20° E. crossed by a fracture zone trending N. 70° E. The topography shows ridges and troughs, from 4600 to 6100 m in depth. Roughness is masked by 600 m of sediment in flat fingers; deep unfilled valleys emphasize the continuity of ridges bounding the fingers. Correlation of magnetic anomalies with Vine's (1960) profiles gives a lower Eocene age for the area; dates on two sediment cores are lower Eocene and Eocene. The cores are part of a pelagic blanket across the area and underlying the plain sediments; topography controls type of sedimentation and thickness. Data from this study support ocean-floor spreading modified by depositional processes.—*from* Author's abstract

07450 **McIlhenny, W. F.** Chemicals from the sea, *in* Forum on geology of industrial minerals, 4th, Austin, Tex., 1968, Proc.: Austin, Tex., Univ. Texas Bur. Econ. Geology, p. 35-44, illus., tables, 1968.

More than 77 elements have been found dissolved in sea water, and the detection of other elements depends only upon analytic ability. Nine major components are commercially important: Na, Mg, Ca, K, Sr, chloride, sulfate, bicarbonate, and bromide. The types of minerals capable of being recovered from sea water are those which are widely distributed. Common salt, Mg metal, and Mg compounds, Br, and fresh water are now currently being produced. K compounds have been produced from residual solar salt bitterns. Authigenic minerals, particularly marine, are formed by precipitation, such as manganese nodules, phosphorites, glauconites, and oolitic aragonite. Calcium carbonate and SiO_2 are removed for use by organisms, and iodine has been recovered from sea plants.—*from* Author's abstract

07504 **McIntyre, Donald B.** Impact metamorphism at Clearwater Lake, Quebec, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 363-366, illus., 1968.

Photomicrographs of granitic microbreccias and other rocks from islands in Clearwater Lake are presented, which exhibit features that are considered evidence of impact metamorphism.—MS

07432 **McKercher, R. B.** Studies on soil organic phosphorus [with French and German summ.], *in* Internat. Cong. Soil Sci., 9th, Adelaide, Australia, 1968, Trans., V. 3: New York, American Elsevier Publishing Co., p. 547-553, table, 1968.

Methods of analyses for total organic phosphorus are briefly considered [contrasting extraction and ignition values in some Canadian soil profiles]. Discussion of some individual chemical groups or components of the organic phosphorus fraction in the soil follows: Particular attention is directed to the inositol phosphates and the fractionation carried out on various soils. Mention is made of a fraction containing more organically bound phosphorus than the inositol phosphate fraction, which occurred in a Canadian Rego Dark Brown Chernozemic soil [from Saskatchewan].—Authors' summary

McManus, Dean A. *See* Echols, Ronald J. 01669

McNeal, James E. *See* Yedlosky, Robert J. 01577

01959 **Meade, Robert H.** Landward transport of bottom sediments in estuaries of the Atlantic Coastal Plain: Jour. Sed. Petrology, v. 39, no. 1, p. 222-234, illus., table, 1969.

River borne sediment is partially trapped in estuaries of the Atlantic Coastal Plain by the predominantly landward flow of estuarine bottom water and accumulates near the upstream limit of landward flow. Bottom waters of the shelves are also known to move into estuaries, carrying sediment. Beach sands also move into estuary mouths, and distinctive mineral components in the lower reaches of estuaries suggest that the bottom sediments were derived from offshore. The rates of filling are different in the north and the south. The large northern rivers carry low loads and have not yet filled the deeply-cut ice-age valleys; the southern rivers carry large loads of sediments and so have largely filled their valleys.—*from* Author's abstract

07357 **Meade, Robert H.** Relations between suspended matter and salinity in estuaries of the Atlantic seaboard, U.S.A., *in* Geochemistry, precipitation, evaporation, soil-moisture, hydrometry—General Assembly of Bern, 1967, Repts. and Discussions: Internat. Assoc. Sci. Hydrology Pub. 78, p. 96-109, illus., tables, 1968.

Concentrations of suspended matter in these estuaries show no accelerated decrease attributable to salt flocculation, contrary to experimental evidence. Velocities of the waters are apparently sufficient to keep the material in suspension. Decrease in suspended matter associated with increasing salinity seaward can be attributed to dilution by sea water. Superimposed on this seaward decrease in suspended concentration is a maximum concentration near the upstream limit of sea salt, with concentrations decreasing both up- and down-stream from it. This seems to reflect accumulation of suspended matter near the salt limit by net landward flow along the bottom.—ESL

07364 **Medina Rivero, Flavio.** Agua subterránea en un sumidero yesoso: Geología y Metalurgia, v. 4, no. 25, p. 33-42, illus., table, 1968.

A geohydrological study has been carried out in the gypsiferous zone of the southern Gomez Farias-El Vergel Valley in Coahuila to locate subterranean water for domestic use. From localization of the water in the zone of sinks existing throughout the valley, it is demonstrated that these sinks are the principal source of recharge to aquifers below the gypsum cap. The waters are gypsiferous, but are consumed by the population of Gomez Faria because of the shortage of other water in the environs.—*from* Author's Spanish abstract, VSN

01743 **Medlin, J. H.; Suhr, N. H.; Bodkin, J. B.** Atomic absorption analysis of silicates employing $LiBO_2$ fusion [abs.]: Georgia Acad. Sci. Bull., v. 27, no. 2, p. 91, 1969.

01809 **Mellor, Malcolm; Testa, Richard.** Effect of temperature on the creep of ice: Jour. Glaciology, v. 8, no. 52, p. 131-145, illus., tables, 1969.

Creep tests on homogeneous, isotropic polycrystalline ice gave an apparent activation energy for creep of 16.4 kcal/mol over the temperature range -10° to -60°C. Above -10°C the Arrhenius relation for temperature dependence is invalid, and creep rate becomes progressively more temperature dependent as the melting point is approached. Between -20° and -50°C the apparent activation energy for creep of a single crystal of ice was 16.5 kcal/mol. A complete creep curve for a single crystal loaded in uniaxial compression parallel to the basal plane was qualitatively similar to the classical creep curve; creep rate at all stages was very much faster than for polycrystalline ice under the same conditions. Tests on polycrystalline ice at 0°C gave a stress/strain-rate relation for that temperature, but its precise meaning is unclear.—*from* Authors' abstract

01851 **Mellor, Malcolm; Testa, Richard.** Creep of ice under low stress: Jour. Glaciology, v. 8, no. 52, p. 147-152, illus., table, 1969.

Uniaxial compressive creep tests on fine-grained polycrystalline ice indicate that secondary strain-rate is proportional to $\sigma^{1.8}$ where σ is applied stress, for the range $0.1 < \sigma < 0.5$ kgf/cm² ($10 < \sigma < 50$ kN/m²). On the basis of the present tests, earlier results suggesting linear viscous behavior at low stress are believed to be invalid.—Authors' abstract

Menendez, L. *See* Alvarez, U. 01983

01949 **Merrill, Glen Kenton.** Allegheny (Pennsylvanian) conodonts [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3365B, 1969.

01862 **Meyer, W. T.** Uranium in lake water from the Kaipokok region, Labrador, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 377-394, illus., 1969.

Lake water surveys for U were found to be a significant aid to airborne exploration in an area of known mineralization in the Kaipokok region of Labrador where there are

numerous uranium occurrences. Seasonal variations in U concentration are apparent in a comparison of data from lakes sampled in both September and July, with a 3- to 4-fold increase in lake water U content in the autumn. This factor contributed to a median uranium concentration of 0.4 ppb for an orientation survey, compared with the 0.1 ppb median value of the mid-summer regional sampling. The biochemical cycle of U was found to be particularly important in interpreting results due to the accumulation of U in the organic material contributed by marginal swamps.—KAF

01621 **Meyerhoff, A. A.** Continental shelf positions during geologic time [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 732-733, 1969.

Middleton, G. V. *See* Parkash, B. 01611

01870 **Miesch, A. T.** Experimental design in geochemical exploration [abs.], *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 512, 1969.

01744 **Mitchell, Jeffrey Leonard; Bagby, Robert.** The sedimentary environment of conodonts in the Chattanooga Shale, Catoosa County, Georgia [abs.]: Georgia Acad. Sci. Bull., v. 27, no. 2, p. 91-92, 1969.

01622 **Moiola, R. J.; Weiser, Daniel.** Environmental analysis of ancient sandstone bodies by discriminant analysis [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 733, 1969.

Möller, Jörgen. *See* Larsen, Ole. 07415

07365 **Monroy Plowers, Salvador.** Breves notas sobre la geología del mineral de Catorce: Geología y Metalurgia, v. 4, no. 25, p. 43-45, 1968.

The mining region of Catorce, about 100 km north of the city of San Luis Potosí, is on the highest part of an isolated uplift which extends N-S for about 4 km and has a width of about 3 km. The sedimentary arc of the uplift has been deflected to the east and west of a central line and the small central valley has bordering escarpments along which are exposed rocks ranging from a green argillaceous schist at the bottom up through shale, breccia, and limestone. Mines are developed at the base of the sediments and mineralized veins carry some silver.—VSN

07344 **Moore, Donald O.; Eakin, Thomas E.** Water-resources appraisal of the Snake River basin in Nevada: Nevada Div. Water Resources, Water Resources—Reconn. Ser. Rept. 48, 103 p., illus., tables, 1968.

Relatively steep gradients and deeply entrenched streams in the Snake River basin combine to produce relatively high runoff, restrict natural areas of evapotranspiration of surface and ground water, and have streams functioning as ground-water drains. Along the flood plain, high stream stages tend to recharge the ground-water system; however, ground water tends to discharge to streams during periods of low streamflow. Ground-water development by wells has been small; wells that tap volcanic rocks have yields from 1,250-2,500 gpm, but these may not be typical. Additional development is possible, but only subject to existing water rights and agreements. The few selected chemical analyses suggest that water is of good quality.—MCM

Moosburner, Otto. *See* Stulik, R. S. 01985

Morey, Elsie Darrah. *See* Morey, Philip R. 01711

01711 **Morey, Philip R.; Morey, Elsie Darrah.** Observations on epon embedded Griffin Hill Peat (Massachusetts), Two Creeks *Picea* (Wisconsin), *Cedrus penhallowii* (Sierra Nevada, California), and *Callixylon* (Delaware, Ohio): Palaeontographica, ser. B, v. 125, nos. 1-3, p. 73-80, illus., 1969.

The distribution of lignin and the lamellation of cellulose has been studied in secondary tracheids of epon embedded Griffin Hill Peat (Massachusetts), Two Creeks *Picea* (Wisconsin), and *Cedrus penhallowii* (Sierra Nevada) and *Callixylon* (Delaware, Ohio). An embedding technique is described which makes practicable the microtomy of fossil woods and other paleobotanical materials for structural studies in the transmitted light microscope. The method appears to be applicable to specimens in which organic continuity can be maintained during processing for embedment.—*from* Authors' abstract

Morin, Ronald W. *See* Bandy, Orville L. 01694

Morris, R. L. *See* Tixier, M. P. 07346

01811 **Morrow, Norman R.; Huppler, John D.; Simmons, A. Barlow, 3d.** Porosity and permeability of unconsolidated, upper Miocene sands from grain-size analysis: Jour. Sed. Petrology, v. 39, no. 1, p. 312-321, illus., table, 1969.

Core analysis data for 78 cores taken from upper Miocene sands were used to develop correlations between porosity and permeability of unconsolidated cores and their grain-size analyses. The grain-size distributions of the cores are best described mathematically by the Rosin-Rammler equation. The two parameters of this equation together with two other easily measured parameters of grain size were grouped to give correlations with porosity and permeability. Porosities were correlated to within 2 percent for 80 percent of the samples and permeabilities were correlated to within a factor of 2 for 70 percent of the samples.—Authors' abstract

01926 **Moyer, Paul Tyson, Jr.** The geology and amphibolites of the Brock-St. Urcisse area, Abitibi and Mistassini territories, Quebec [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2942B-2943B, 1969.

07455 **Muehlberger, William R.; Clabaugh, Patricia S.** Internal structure and petrofabrics of Gulf Coast salt domes, *in* Forum on geology of industrial minerals, 4th, Austin, Tex., 1968, Proc.: Austin, Tex., Univ. Texas Bur. Econ. Geology, p. 81-89, illus., 1968.

Internal structures and preferred orientation of halite crystals in Grand Saline salt dome, Texas, and Winnfield salt dome, Louisiana, indicate emplacement of the stocks by successive differential movement of spines and lobes. Differences in intensity of shear folding and varied degrees of preferred orientation in these and other Gulf Coast salt domes suggest that mines within the domes are at different structural levels and that movement of the salt has, in some cases, been very complex. Study of the preferred orientation of bedded salt from Oklahoma showed that it increases with depth.—Authors' abstract

Muller, J. *See* Germeraad, J. H. 07373

01971 **Mulligan, R.** Metallogeny of the region adjacent to the northern part of the Cassiar Batholith, Yukon Territory and British Columbia (Parts of 104 O, P and 105 B): Canada Geol. Survey Paper 68-70, 13 p., illus., tables, 1969.

The northern part of the Cassiar region, in the Yukon-British Columbia boundary country between Watson Lake and Teslin, is an area of extraordinary structural complexity, and of numerous and varied mineral occurrences. The Cassiar asbestos mine is the only major producer but gold is still being won from the old McDame placer field. Several of many small silver-lead-zinc deposits and two of the molybdenite deposits have been intensively explored in recent years. Tungsten deposits of two types are of possible economic interest. Of special metallogenic interest are the numerous minor beryllium and tin occurrences in the district.—Author's abstract

01623 **Murray, R. C.** Evaporative reflux hydrology of south Bonaire, Netherlands Antilles [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 733, 1969.

02026 **Murty, T. S.** Thermal convection in vertical tubes with application to geysers: Tellus, v. 21, no. 1, p. 54-63, illus., tables, 1969.

Thermal convection in vertical tubes has been studied theoretically as an initial value problem using numerical techniques. The thermal and viscous boundary layers at the wall are taken into account approximately. Special emphasis is placed on the geophysical application of this problem, particularly in examining the convective theories of geyser eruptions from a hydrodynamic point of view and determining the forms of convection during the preliminary stage before boiling starts. The proper time scales and other associated properties are explained through determining the appropriate eddy coefficients.—Author's abstract

07452 **Myers, John C.** Gulf Coast sulfur resources, *in* Forum on geology of industrial minerals, 4th, Austin, Tex., 1968, Proc.: Austin, Tex., Univ. Texas Bur. Econ. Geology, p. 57-65, illus., table, 1968.

Of 174 salt domes whose cap rock lies above 3,000 feet, located on and offshore in the Gulf Coast of the United States, only 26 have produced sulfur by the Frasch process. In Mexico, five domes have produced sulfur to date. Sulfur is found in the transition zone in the caprock of a salt dome, below a limestone cap and above a calcium sulfate base. Thus, carbonate content increases and sulfate content decreases with an increase in sulfur. Future prospects for additional sulfur in the United States and Mexico lie entirely with salt dome development.—*from* Author's abstract

Nabetani, Sachio. *See* Rankin, David. 07397

02028 **Nagasawa, Hiroshi; Wakita, Hiroshi; Higuchi, Hideo; Onuma, Naoki.** Rare earths in peridotite nodules—An explanation of the genetic relationship between basalt and peridotite nodules: Earth and Planetary Sci. Letters, v. 5, no. 6, p. 377-381, illus., table, 1969.

Rare earth abundances in peridotite (lherzolite) nodules and mineral fractions separated from them were measured by neutron activation analysis. Rare earths in a possible liquid phase which could have equilibrated with the nodules were calculated on the basis of trace element partition. In comparing these calculated patterns with those of the actual basalts, it is suggested that the nodules would have no genetic relationship to host basalts but would be fragments of deep-seated peridotitic masses which had once supplied basaltic magma.—Authors' abstract

Nakagawa, H. M. *See* Ward, F. N. 01865

01957 **Neal, William J.** Carbonate facies and paleogeography of the Blackjack Creek Formation (Pennsylvanian). Missouri: Jour. Sed. Petrology, v. 39, no. 1, p. 34-48, illus., table, 1969.

Petrographic analyses and field mapping of the thin lower carbonate unit of this formation revealed seven facies which reflect local sets of hydrographic conditions, that were largely controlled by sea floor topography and local tectonism. Shale-limestone lithofacies in the upper Blackjack Creek correlate with the facies of the lower carbonate unit. The sedimentologic-structural settings and their resulting facies are: (1) turbid shelf-syncline—Fulton Lime Mudstone, (2) Lagoon/mudflat-restricted platform—burrowed dolomite-mudstone, (3) shoal-sediment platform—platy-algal facies, (4) open to restricted shelf-interplatform—burrowed fragmental facies, (5) high-energy bank-anticline—oncolitic calcarenite, (6) lagoon-positive area flank—burrowed Wilkingia Dolomite, and (7) regression off of shoal-sediment platform flank—fusulinid-crinoidal packstone.—*from* Author's abstract

01570 **Neidell, Norman S.** Ambiguity functions and concept of geological correlation [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 734, 1969.

01900 **Nelson, Carlton Hans.** Marine geology of Astoria deep-sea fan [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 3018B-3019B, 1969.

Nettleton, W. D. *See* Flach, K. W. 07418

01617 **Neumann, A. Conrad; Gebelein, Conrad D.; Scoffin, Terence P.** Composition, structure, and erodability of subtidal mats, Abaco, Bahamas [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 734, 1969.

01935 **Newbury, Robert William.** The Nelson River—A study of subarctic river processes [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3308B, 1969.

Newell, Norman D. *See* Boyd, Donald W. 01704

07393 **Newton, J. G.** Geology, *in* Mineral and water resources of Barbour County, Alabama: Alabama Geol. Survey Inf. Ser. 37, p. 5-10, illus., geol. map, 1968.

Geologic units that crop out in Barbour County range in age from Late Cretaceous to Recent; their contacts as mapped agree with earlier work, with slight modification of the Selma Group (Eargle, 1950). The combined thickness (8 named units and terrace and alluvial deposits) ranges from 300 feet in the northern part of the county to 1,300 feet in the southern part; the formations strike east-west and dip south-southeast at a decreasing angle. Descriptions are summarized briefly for the Bluffton and Ripley Formations, Providence Sand, Clayton and Nanafalia Formations, Tuscahoma Sand, the Tallahatta and Hatchetigbee Formations, and high and low terrace deposits and alluvial basins.—GDC

01906 **Neyestani, Mohammad.** The effect of water application rate on infiltration and wetting front characteristics of unsaturated silt loam soil [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2709B, 1969.

Nichol, I. *See* Horsnail, R. F. 01888

Nichol, Ian. *See* Garrett, R. G. 01883

01762 **Nicholls, J.; Carmichael, J. S. E.** Peralkaline acid liquids—A petrological study: Contr. Mineralogy and Petrology, v. 20, no. 3, p. 268-294, illus., tables, 1969.

Electron-microprobe analyses of the feldspars and associated ferromagnesian minerals in peralkaline volcanics, comendites and pantellerites, are presented together with new data on the major and trace-elements of the rocks and residual glasses. The feldspar phenocrysts in the pantellerites span a narrower range than those of the comendites; both sets show a limited increase in Or outwards and the zoning is greatest in quartz-bearing assemblages. Of the ferromagnesian phenocrysts, aenigmatite is the most ubiquitous and aside from a slight variation in Ti/Fe + Ti ratio the composition is constant. The characteristic patterns of the trace elements in peralkaline volcanics are considered to be as much evidence for the peralkaline condition as of the genetic process.—*from* Authors' abstract

Nichols, M. C. *See* Kahn, J. S. 07473

Nichols, Stanley A. *See* Lindsey, Alton A. 02040

01936 **Noble, Calvin Athelward.** The effect of temperature on strength of soils [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3308B-3309B, 1969.

01715 **Noble, Donald C.; Haffty, Joseph; Hedge, Carl E.** Strontium and magnesium contents of some natural peralkaline silicic glasses and their petrogenetic significance: Am. Jour. Sci., v. 267, no. 5, p. 598-608, illus., tables, 1969.

Nonhydrated comendite and pantellerite glasses are extremely impoverished in Sr, containing from less than 2 to less than 10 ppm of the element. Most of the glasses also contain less than 0.05 wt percent MgO, and many contain 0.02 wt percent or less. Such pronounced depletion of these elements can only have resulted from protracted fractional crystallization. Calcium is not so markedly depleted, with CaO contents averaging about 0.3 wt percent. Pronounced increase in Ca relative to Sr probably is a characteristic feature of all highly differentiated silicic melts. Glasses from the lowermost parts of several compositionally-zoned ash flow sheets contain 2

ppm or less of Sr and less than 0.03 wt percent MgO. These data support a fractional-crystallization origin for at least part of the elemental and mineralogical zonation of the parent magmas.—*from* Authors' abstract

01927 **Nold, John L.** Geology of the northeastern border zone of the Idaho batholith, Montana and Idaho [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2943B, 1969.

Nordeng, Stephen C. *See* Ruotsala, Albert P. 01873

07401 **Nordin, Carl F., Jr.** Statistical properties of dune profiles [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 3, p. 1014B-1015B, 1968.

01758 **Norris, D. K.; Barron, K.** Structural analysis of features on natural and artificial faults, *in* Research in tectonics: Canada Geol. Survey Paper 68-52, p. 136-167, illus.; discussion, p. 167-174, illus,, 1969.

Field and laboratory data indicate that accretion steps are formed as slip surfaces are parted, and depending on which wall retains the gouge, the steps will face in one direction or other. Because the gouge is more readily bonded to the lee flank of ir—regularities, however, it commonly sticks there so that risers face preferentially in the direction of motion of the opposed block. Fracture steps on the other hand can face in either direction and cannot be used indiscriminantly as a definite criterion for sense of slip. Where their nature and origin are understood, however, both kinds of steps can be used with meaningful samples of pitch measurements to establish directions of slip and therefore to document at least part of the kinematic history of faulting and folding in orogenesis.—*from* Authors' abstract

01838 **Norris, Robert M.** Dune reddening and time: Jour. Sed. Petrology, v. 39, no. 1, p. 7-11, 1969.

Many dune sands become reddened with the passage of time. The process is promoted by warm temperatures, oxidizing conditions, and the periodic presence of moisture. Reddening is due to the gradual weathering of iron oxide and silicate mineral grains; the weathering tends to cause the coatings to become thicker and affects increasing numbers of grains with the passage of time. In addition the he—matitic grain coatings are resistant to the abrasion associated with eolian transport. It is suggested that the basic requirements for development of hematitic weathering products—warm temperatures, oxidizing conditions, and the occasional presence of moisture—are regularly met in most tropical and sub-tropical dunes, even those in very dry environments, because of the ability of dune sands to absorb and retain rainfall.—*from* Author's abstract

01750 **Norton, Norman J.; Hall, John W.** Palynology of the Upper Cretaceous and lower Tertiary in the type locality of the Hell Creek Formation, Montana, U.S.A.: Palaeontographica, ser. B, v. 125, nos. 1-3, p. 1-64, illus., tables, 1969.

When long-ranging species are excluded, three floristic assemblages become ap—parent. The Upper Cretaceous assemblage extends from the Bearpaw Shale upward into the Hell Creek Formation. Forty-two percent of all the species are in this flora. A transition assemblage is composed of types that occur within the lithologic and stratigraphic limits of a portion of both the Upper Cretaceous and lower Fort Union assemblages; 22 percent of all the species occur in this flora. Included in the upper—most assemblage, the lower Fort Union assemblage, are 16 percent of all the species. Characteristic species in each assemblage are discussed and described.—HRC

Oberbeck, Verne R. *See* Gault, Donald E. 07406

Obradovich, J. D. *See* Izett, G. A. 01761

07487 **Obradovich, J. D.; Peterman, Z. E.** Geochronology of the Belt Series, Montana, *in* Geochronology of Precambrian stratified rocks—Internat. Conf., Edmonton, Al—berta, 1967, Papers: Canadian Jour. Earth Sci., v. 5, no. 3, pt. 2, p. 737-747, illus., tables, 1968.

New radiometric data are presented that permit qualified statements to be made on the depositional history of the Belt sedimentary rocks. Three distinct periods of sedimentation for the Belt series are suggested at >1300, 1100, and <900 m.y., with two substantial hiatuses of 200 m.y. or more. In addition, data for the sequence in the Big and Little Belt Mts. suggest that sedimentation may not have commenced for a period of possibly 400 m.y. after the metamorphism that affected basement rocks, while data for the Garnet Range and Pilcher sequence suggest sedimentation ceased 200 to 400 m.y. prior to deposition of the Middle Cambrian Flathead Quartzite. The viewpoint that the Belt basin has been characterized by discontinuous sedimentation is in keeping with the principle of uniformity.—*from* Authors' abstract

Odom, I. Edgar. *See* White, W. Arthur. 01592

Olsson, Richard K. *See* Fox, Steven K., Jr. 01676

01618 **Olsson, Richard K.** Planktonic Foraminifera from base of Tertiary, Millers Ferry, Alabama [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 734, 1969.

Onat, E. T. *See* Dieterich, J. H. 01728

01834 **Ondrick, Charles W.; Griffiths, John C.** Trend surface analysis applied to the Rensselaer Graywacke and its implications to the Taconics: Jour. Sed. Petrology, v. 39, no. 1, p. 176-186, illus., tables, 1969.

This formation, near Troy, was investigated with a view to determining any discernible trends in petrographic and geochemical variables; 119 samples from 58 locations, and 33 preliminary samples from 8 sites were examined. Thirty-eight variables were investigated. Earlier-conceived hypotheses of origin of the formation were tested against the derived patterns, and four sources of clastic material are suggested. An unusual grain elongation is of regional magnitude on the eastern and northern margins and possibly reflects a shear zone of regional extent. Sixth order trend surfaces for Na_2O, K_2O, Cu, MgO, and MnO are very similar in that they each indicate a north-northeast axial trend. The internal structure of the Rensselaer controls these trends and appears to conform with the general trend of the Taconics.—HRC

01889 **Ong, H. Ling; Swanson, Vernon E.** Natural organic acids in the transportation, deposition, and concentration of gold, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 395-425, illus., tables, 1969.

Interactions of various forms of gold with different types of natural organic acids show that gold is not oxidized and complexed by the organic molecules. On the contrary, organic concentrations in the range of 3 to 30 ppm have the capacity to reduce gold chloride solutions to negatively charged colloids of metallic gold. The significances of this study in geochemical processes involving gold mobility are: (1) In a very acidic solution where gold is soluble as its chloride and organic acids are not soluble, the presence of solid organic matter causes the reduction of gold chloride, and metallic gold of colloidal size will be precipitated; (2) in slightly acidic to basic waters gold can only be transported as stable organic protected colloids; and (3) organic-protected gold colloids are precipitated when they enter a different chemical environment.—*from* Authors' abstract

Onuma, Naoki. *See* Nagasawa, Hiroshi. 02028

01571 **Orlansky, Ralph.** Significance of palynomorphs as sedimentation indicators in Cretaceous Straight Cliffs Sandstone, Utah [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 734-735, 1969.

07384 **Outerbridge, William F.; VanVloten, Roger.** Geologic map of part of the Jamboree quadrangle, Pike County, Kentucky: U.S. Geol. Survey Geol. Quad Map GQ-775, scale 1:24,000, section, text, 1968.

Mined coal beds in the Jamboree quadrangle are the Fire Clay(?), Upper Elkhorn Nos. 1 and 2, Lower Elkhorn, Clintwood, Eagle, Glamorgan, Hagy, and Splash Dam. Natural gas has been produced from the Mississippian Ravencliff and Maxton sands and Newman Limestone, Mississippian or Devonian Berea Sandstone, and the Devonian Ohio Shale. Sandstone of the Breathitt Formation has been used locally.—MCM

01572 **Owen, Donald E.; Ingram, Roy L.** Practical comparison of methods of computing grain-size parameters [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 735, 1969.

07399 **Pabian, Roger K.; Fagerstrom, J. A.** Biometrical study of morphology and development of the Pennsylvanian trilobite *Ameura sangamonensis* (Meek and Worthen): Nebraska Univ. State Mus. Bull., v. 8, no. 2, p. 189-207, illus., tables, 1968.

Biometrical study of morphology and development in 100 cranidia, 94 pygidia, 26 free cheeks, and 9 complete specimens of *Ameura sangamonensis* from the Bonner Springs Shale, Missouri Series, in eastern Nebraska indicates that the dominant growth pattern was isometric. Rectilinear size relations among 8 pairs of cranidial dimensions, 3 pairs of pygidial dimensions, and 3 pairs of free cheek dimensions support this conclusion. Quantitative changes in pygidial morphology during development include progressive decrease in prominence of the border, increasing width of posterior relative to lateral borders, and progressive change in margin outline from rounded semicircular to subtriangular or subparabolic. All the complete specimens are holaspides; if some late meraspid cranidia are present, they are morphologically very similar.—*from* Authors' abstract

01991 **Page, Leo M.** The use of the geoelectric method for investigating geologic and hydrologic conditions in Santa Clara County, California: Jour. Hydrology, v. 7, no. 2, p. 167-177, illus., table, 1969.

Results are reported from a study of the application of resistivity methods to exploration of geologic and hydrogeologic conditions near existing and potential ground-water recharge facilities in the Santa Clara Valley. Basic procedures are described briefly. Since 1964, over 800 electric soundings to depths of 200-500 feet and over 10,000 profile probes to depths of 20-30 feet have been carried out. Several hundred acres of good percolation ground in off stream areas have been delineated and permeable zones discovered in many major stream channels; additional potential recharge capacity of newly discovered areas is more than 100,000 acre-feet per yr. Limitations to the method are noted.—VSN

01928 **Palmer, Donald Frank.** Geology and conditions of metamorphism at Benson Mines, New York [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2943B, 1969.

02027 **Papanastassiou, D. A.; Wasserburg, G. J.** Initial strontium isotopic abundances and the resolution of small time differences in the formation of planetary objects: Earth and Planetary Sci. Letters, v. 5, no. 6, p. 361-376, illus., tables, 1969.

Differences in the Sr-87/Sr-86 ratio corresponding to about 10^{-2} percent are clearly resolvable using improved instrumental techniques. Several basaltic achondrites having a total spread of 0.2 percent in Sr-87/Sr-86 were studied and appear to define an identical initial Sr-87/Sr-86 abundance corresponding to 0.698976 ± 0.000055 (maximum uncertainties). These samples lie on a well-defined isochron with a slope of 0.0629 ± 0.0037 and an age of $4.39 \pm 0.26 \times 10^9$ years for $A = 1.39 \times 10^{-11}$ yr^{-1}. The maximum deviation for a data point from the best fit line is 6×10^{-3} percent. If the samples were derived from material with chondritic or solar Rb/Sr abundance ratios, they were formed within a time period of 4 or 1.6 m.y., respectively. The application of measurements to refinement of early solar system chronology is discussed.—*from* Authors' abstract

Papike, J. J. *See* Himmelberg, G. R. 02042

01611 **Parkash, B.; Middleton, G. V.** Grain and graptolite orientation in turbidite graywacke, Cloridorme Formation (Ordovician), Gaspé, Quebec [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 735, 1969.

01612 **Parks, James M.** Multivariate facies maps [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 735, 1969.

07447 **Patton, John B.** The view from the forum *in* Forum on geology of industrial minerals, 4th, Austin, Tex., 1968, Proc.: Austin, Tex., Univ. Texas Bur. Econ. Geology, p. 3-6, 1968.

The forum on industrial minerals originated because the principles of economic geology have been less systematized for the nonmetallics than for ores and fossil fuels. Textbooks pointed toward nonmetallics are few, most having been written by ore geologists who viewed all mineral occurrences as "deposits" in the sense of localized bodies. While some industrial minerals lend themselves to this approach, many do not. New ideas and data, especially in sedimentology and geochemistry are waiting to be incorporated into the study of industrial minerals, and new instruments and investigative methods, developed only within the last few years, have yet to be broadly applied to nonmetallic minerals.—*from* Author's abstract

01613 **Pecora, W. T.** Mineral resource potential of continental margin of United States [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 735-736, 1969.

02010 **Perrault, Guy; Semenov, E. I.; Bikova, A. V.; Capitonova, T. A.** La lemoynite, un nouveau silicate hydraté de zirconium et de sodium de St. Hilaire, Québec [with English and Russian abs.]: Canadian Mineralogist, v. 9, pt. 5, p. 585-596, illus., tables, 1969.

Lemoynite occurs in pegmatites of the St. Hilaire alkaline massif, and is probably hydrothermal. A radiocrystallographic study shows that for lemoynite the crystallographic directions according to mineralogic and crystallographic usages are contradictory, and the latter usage is preferred by the authors. The formula $(Na,Ca)_2Zr_2Si_6O_{22}\times 8H_2O$ agrees with analyses. The Debye-Scherrer diagram is tabulated, and infrared absorption spectra for natural and heated specimens are given. Lemoynite is compared with other hydrated silicates of zirconium.—ESL

07414 **Perry, Kenneth, Jr.** Representations of mineral chemical analyses in 11-dimensional space—Pt. 2, Amphiboles: Lithos, v. 1, no. 4, p. 307-321, illus., tables, 1968.

Most major chemical variations within the amphibole group are expressed in terms of 11 oxides. Granting this assumption, the total error for a given chemical analysis is minimized when the amphibole composition space is represented by an 11×10 matrix A and $\bar{x}$ is computed using some 10×10 matrix from A. It has not been possible thus far, using common amphibole 'end' members, to define a representation A within which $x_j > 0$ for all j for a single amphibole analysis. It is possible, however, to generate a set of molecules which obey charge balance and certain structural constraints of the amphibole group and which define a composition space within which natural amphiboles lie. It is concluded that the natural amphiboles cannot be represented graphically.—*from* Author's abstract

01846 **Pestrong, Raymond.** A multipurpose soft sediment sampler: Jour. Sed. Petrology, v. 39, no. 1, p. 327-330, illus., 1969.

A multipurpose sampler has been developed for use in soft, cohesive sediments. It can be operated by one man and can recover cores to depths of 15 feet, depending upon the consistency of the material and the available manpower. Additional unique features include: transparent removable plastic core barrels for easy viewing and transport of the core and an attachment enabling the recovery of a 1/2-inch thick rectangular slice, completely wrapped in plastic film, ready for photographic or X-ray radiographic analysis.—Author's abstract

01847 **Pestrong, Raymond.** The shear strength of tidal marsh sediments: Jour. Sed. Petrology, v. 39, no. 1, p. 322-326, illus., 1969.

The shear strength of soft cohesive muds may be rapidly and accurately calculated from laboratory investigations with an unconfined compressive strength testing device that is inexpensive and simple to construct. Utilizing this device, the shear strength of "undisturbed" cores of tidal flat and tidal marsh sediments from the San Francisco Bay was measured, with the highest values consistently associated with the organically rich, denser, marsh deposits.—Author's abstract

Peterman, Z. E. *See* Obradovich, J. D. 07487

07486 **Peterman, Zell E.; Hedge, Carl E.** Chronology of Precambrian events in the Front Range, Colorado, *in* Geochronology of Precambrian stratified rocks—Internat. Conf., Edmonton, Alberta, 1967, Papers: Canadian Jour. Earth Sci., v. 5, no. 3, pt. 2, p. 749-756, illus., 1968.

Before 1750 m.y. ago sedimentation and volcanism in the Front Range area resulted in accumulation of thousands of feet of sandstone and shale, and lesser amounts of calcareous and volcanic rocks on a basement terrane not as yet recognized. Regional and dynamic metamorphism at 1700 to 1750 m.y. ago converted the pile into medium- to high-grade gneisses and schists; plutonic rocks typified by Boulder Creek Granite were emplaced. After this, there is a time span of 200 to 250 m.y. for which there is no geologic record. The interval 1390 to 1450 was a period of major igneous activity; tectonic activity along the great shear zone that trends northeast through Idaho Springs probably began during this orogeny and may have continued to about 1200 m.y. ago. Pikes Peak batholith and smaller granites were emplaced 1040 m.y. ago, accompanied by regional metamorphism.—*from* Authors' abstract

01857 **Peterson, James A.; Hite, Robert J.** Pennsylvanian evaporite-carbonate cycles and their relation to petroleum occurrence, southern Rocky Mountains: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 4, p. 884-908, illus., table, 1969.

The Paradox and Eagle basins of southeastern Utah and western Colorado contain a thick series of Pennsylvanian evaporites. In the deeper parts of these basins halite and potash were deposited, whereas on the basin shelves carbonates were predominant. Biogenic carbonate mounds within the shelf facies contain most of the petroleum found in the Paradox basin. Similar relatively untested mounds are in the Eagle basin. The evaporite environment may play a direct role in the generation and accumulation of petroleum. Barred basins concentrate oceanic salts and are an efficient trap for organic matter. The introduction of the organic matter may be accelerated by the basinward flow of nutrient-rich water resulting from evaporation in the basin. The anoxic conditions and high levels of H_2S in the basin allows preservation of organic matter.—EAM

02011 **Petruk, W.; Harris, D. C.; Stewart, J. M.** Langisite, a new mineral, and the rare minerals cobalt pentlandite, siegenite, parkerite and bravoite from the Langis mine, Cobalt-Gowganda area, Ontario: Canadian Mineralogist, v. 9, pt. 5, p. 597-616, illus., tables, 1969.

An unusual assemblage of arsenides, sulfides, and native bismuth has been found in an ore-bearing fault vein. A cobalt monoarsenide, for which the name langisite is proposed, is new, and corresponds to the cobalt-rich end member of the NiAs isostructural series. Other arsenides are safflorite and maucherite. Sulfides consist of two sub-assemblages, one of intergrown pyrite and marcasite, and the other of bismuthinite, parkerite, cobalt pentlandite, siegenite, bravoite, and a late pyrite. Parkerite is bismuth-rich, and siegenite, and bravoite are cobalt-rich. The sequence of deposition was arsenides, pyrite-marcasite, native bismuth, other sulfides.—*from* Authors' abstract

01899 **Pevear, David R.** Clay mineral relationships in recent river, nearshore marine, continental shelf, and slope sediments of the southeastern United States [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 3017B, 1969.

01929 **Pezzetta, John Mario.** The St. Clair River delta [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2943B-2944B, 1969.

Phillips, Joseph. *See* Uchupi, Elazar. 01576

Phillips, Joseph. *See* Bowin, Carl O. 01703

Phillips, Joseph D. *See* VanAndel, Tjeerd H. 02007

01861 **Phleger, Fred B.** A modern evaporite deposit in Mexico: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 4, p. 824-829, illus., table, 1969.

The Ojo de Liebre lagoon on the west coast of Baja California has shallow diked basins along its inner part, and evaporite deposition is taking place in these basins. Sea water flows into the basins through tidal channels, and algal photosynthesis and evaporation results in deposits that are to some degree areally segregated. The brines and evaporites support a large number of organisms. The Ojo de Liebre deposits show that bituminous material, which is often associated with evaporites, may be deposited in shallow-water reducing environments. The deposits also furnish clues concerning the time elements involved in the deposition of varved evaporite deposits.—SEF

01614 **Picard, M. Dane; High, Lee R., Jr.** Lacustrine criteria [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 736, 1969.

Picard, M. Dane. *See* High, Lee R., Jr. 01656

01975 **Pickering, R. J.** Distribution of radionuclides in bottom sediment of the Clinch River, eastern Tennessee: U.S. Geol. Survey Prof. Paper 433-H, p. H1-H25, illus., tables, 1969.

The distribution of radioactivity was investigated in cores of bottom sediment taken from a 21-mile-long reach of the Clinch River downstream from Oak Ridge National Laboratory. In the upper 8 mi, radioactive sediment occurs only along the channel sides but, in the lower 13 mi, it extends into the main channel and attains its greatest thicknesses. The general pattern of gross gamma radioactivity with depth resembles that of annual releases of cesium-137 from the laboratory. Measurements of vertical distribution of radionuclides in cores showed 81 percent due to cesium-137, 12 percent to cobalt-60, 7 percent to ruthenium-106. Physical and chemical compositions of sediments showed that cation exchange properties are controlled by content of mica and clay minerals; effect on radionuclide content is obscured by variation in annual releases and by dilution of radioactive by nonradioactive sediment.—*from* Author's abstract

01829 **Pierce, J. W.; Howard, James D.** An inexpensive portable vibrocorer for sampling unconsolidated sediments: Jour. Sed. Petrology, v. 39, no. 1, p. 385-390, illus., 1969.

An inexpensive, portable vibrocorer has been developed for acquisition of cores of sand on barrier islands where transportation facilities are extremely limited. The corer is self-contained and requires a minimum of machine shop alteration to commercially available equipment. Cores to depths of 12 feet have been taken.—Authors' abstract

01958 **Pierce, J. W.; Siegel, F. R.** Quantification in clay mineral studies of sediments and sedimentary rocks: Jour. Sed. Petrology, v. 39, no. 1, p. 187-193, illus., tables, 1969.

Studies of the literature show that at least six different methods are being used to make percentage calculations on clay mineral contents and distributions in sediments. In addition, there is no consistency in sample preparation. The various methods are tested, and all are equally internally consistent. No preference is given to any of the calculation techniques being used because each seems to be as well founded as the others; accurate quantitative results are unattainable although precision is good. Until true quantification becomes possible, the adoption of a unified methodology, possibly under aegis of the Clay Minerals Society, is suggested so that semi-quantitative work may become more meaningful. Without standardization of methods of calculation and preparation, regional studies will remain incomparable.—HRC

Pilkey, O. H. *See* Doyle, Larry J. 07370

Pinson, W. H., Jr. *See* Fairbairn, H. W. 07479

07391 **Pissart, A.** Les polygones de fente de gel de lile Prince Patrick (Arctique Canadien—76° lat. N.) [with English abs.]: Biul. Peryglacjalny, no. 17, p. 171-180, illus., 1968.

The author describes the variety of form and structure of frost fissure polygons on an island in the Queen Elizabeth Archipelago. Polygons formed by wedges of mineral soil, and by wedges of sand and ice have developed together under the present-day climate. Sections through several of these structures are described. The conditions determining which type of polygon has developed, appear to be primarily the granulometry of the soil and its humidity during the summer.—Author's abstract

Plant, A. G. *See* Sabina, Ann B. 02015

Plus-Quellec, Paul L. *See* Sandberg, Phillip A. 01605

01615 **Pohowsky, Robert A.** Studies on sedimentology of shell beds on Bermudian patch reefs [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 736, 1969.

Porter, J. W. *See* Fuller, J. G. C. M. 01856

01745 **Power, W. Robert.** Stratigraphic nomenclature and correlations in the Murphy Marble belt [abs.]: Georgia Acad. Sci. Bull., v. 27, no. 2, p. 92-93, 1969.

Prada, K. E. *See* Uchupi, Elazar. 01576

Prada, K. E. *See* Bowin, Carl O. 01703

Presant, E. W. *See* Protz, R. 07420

Prewitt, C. T. *See* Gibbs, G. V. 07426

01760 **Price, N. J.** A dynamic mechanism for the development of second order faults, *in* Research in tectonics: Canada Geol. Survey Paper 68-52, p. 49-71, illus.; discussion, p. 72-78, 1969.

Increments of displacement on faults commonly occur so abruptly that vibrations of the rock masses are generated. In certain circumstances, the frequency and amplitude of the shock waves and the stresses associated with these vibrations can so alter the static stress field that the orientation and intensities of the principal stresses are momentarily such that small second order fractures may develop. These propagate and extend with the passing of every shock wave and eventually attain the magnitude of second order faults. The angle between the second order fault and the first order structure, and the nature of the movement on the secondary faults depends upon such factors as vertical principal stress, pore-water pressure, and inertial stresses associated with the rock vibrations.—*from* Author's abstract

07420 **Protz, R.; Arnold, R. W.; Presant, E. W.** The approximation of the true modal profile with the use of the high speed computer and landscape control [with French and German summ.], *in* Internat. Cong. Soil Sci., 9th, Adelaide, Australia, 1968, Trans., V. 4: New York, American Elsevier Publishing Co., p. 193-204, illus., tables, 1968.

One hundred observations of horizon thicknesses [of one of Ontario's most variable soils, the Brant series], from a grid pattern based on strict landform control, have been used to establish: 1, a true modal profile, 2, percentage inclusions; 3, relationships between horizon thicknesses. The reproducibility of the modal profile and percent-inclusion has been tested by comparing data from two plots. Close agreement between means, ranges and standard deviation support the concept that this type of sampling approach can be used as a basis for accurately establishing limits of various properties within soil series. When mathematical relationships between various properties are known, the alteration of a classification system can be done easily and in a systematic fashion.—Authors' summary

07478 **Purdy, J. W.; York, D.** Rb-Sr whole-rock and K-Ar mineral ages of rocks from the Superior Province near Kirkland Lake, northeastern Ontario, Canada, *in* Geochronology of Precambrian stratified rocks—Internat. Conf., Edmonton, Alberta, 1967, Papers: Canadian Jour. Earth Sci., v. 5, no. 3, pt. 2, p. 699-705, illus., tables, 1968.

A Rb-Sr whole-rock investigation of two acid intrusive bodies [Round Lake batholith and Otto stock] in the Superior Province of the Canadian Shield have yielded isochrons corresponding to ages of 2.39 ± 0.08 b.y. and 1.73 ± 0.05 b.y. Additional K-Ar data on separated minerals from each of these intrusive bodies supports the Rb-Sr data. The existence of a dike-like intrusion of the 1.73 b.y. rock into the 2.39 b.y. rock is also inferred from the data.—Authors' abstract

Pusey, Walter C. *See* Chuber, Stewart. 01684

Quaide, W. L. *See* Bunch, T. E. 07499

Quaide, William L. *See* Gault, Donald E. 07406

Radtke, Arthur S. *See* Akright, Robert L. 01884

07397 **Rankin, David; Nabetani, Sachio.** The electromagnetic impulse response of the earth and its resistivity structure: Akita Univ. Mining Coll. Jour., Ser. A (Mining Geology), v. 4, no. 3, p. 23-28, illus., 1968.

An application of the magnetotelluric method for interpreting the subsurface resistivity structure of the earth is presented. The impulse response of the earth to an incident electromagnetic disturbance is developed and used to treat data directly in the time domain. An example using data obtained near Leduc, Alberta is interpreted with this method. [Results are shown graphically. Depth of penetration of the method is estimated as 17-30 km.]—Authors' abstract

01616 **Rapson-McGugan, J. E.** Intra-Permian corrosion breccias, southern Canadian Rocky Mountains [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 736-737, 1969.

07475 **Rawson, Donald E.** Characteristics of glasses resulting from nuclear explosions in silicate rock [abs.], *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 626-627, 1968.

07377 **Rebikoff, Dimitri.** Mosaic photogrammetric survey of the Atlantic Continental Shelf off Port Everglades, *in* National symposium on ocean sciences and engineering of the Atlantic Shelf, Philadelphia, 1968, Trans.: Washington, D.C., Marine Technology Soc., p. 249-256, illus., 1968.

The shelf between Palm Beach and Fort Lauderdale, Fla., is exceptionally narrow, but has the same main features as sections from other locations here and abroad. These features are a hard rocky bottom with sand pockets in low areas, and a series of submerged reefs parallel to the shore with undercut cliffs on the sea side. A new underwater photography system for exploration is described which supplements low resolution traverse sonar soundings by mosaic photogrammetric strips.—ESL

01848 **Reiss, Z.; Schneidermann, N.** Ultramicrostructure of *Hoeglundina*: Micropaleontology, v. 15, no. 2, p. 135-144, illus., 1969.

Light microscopy, X-ray analysis and electron microscopy show that foraminifer *Hoeglundina elegans* (d'Orbigny) possesses a bilamellar test composed of hexagonal prisms of aragonite aligned with C-(and X-) axes normal to the surface of the test in a morphologically and optically 'radial' structure. Growth of crystal units proceeds epitaxially from basal pinacoids aligned parallel with the test surface, as determined by stereochemistry of active-passive organic matrices. The latter seem to form a kind of cellular mass, as indicated by configuration of organic material enveloping crystal units within each outer lamella and inner lining, and by distribution of interlamellar sheets of organic material. Observations of organic material are present. Pores occur

in bundles forming 'pore fields' on the surface. Organic pore linings seem closely related to concentrations of organic material.—*from* Authors' abstract

01573 **Rhoads, Donald C.; Waagé, Karl M.** Sediment control of faunal distribution patterns in Late Cretaceous marginal marine deposits of South Dakota [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 737-738, 1969.

Rich, C. I. *See* vonReichenbach, H. 07430

02023 **Riedl, R. J.** Gnathostomulida—Is there a fossil record? [reply to discussions by J. Rodgers and C. J. Durden, 1969]: Science, v. 164, no. 3881, p. 856, 1969.

Rapidly increasing neontological facts strengthen the hypothesis that there is a relationship between conodonts and the new living phylum Gnathostomulida. (Original paper, ibid., v. 163, no. 3866, p. 445-452, 1969; discussions, ibid., v. 164, no. 3882, p. 855-856, 1969.)—DBV

01582 **Rigby, J. Keith.** Reefs and reef environments [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 738, 1969.

Riggs, S. R. *See* Freas, D. H. 07442

07411 **Rinehart, John S.** Intense destructive stresses resulting from stress wave interactions, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 31-42, illus., table, 1968.

Under extremely intense impulsive loading, rock flows and the reactions can be treated hydrodynamically. Under less intense impulsive loading, the laws of elastic behavior are also involved. Analysis of reactions to stress on the basis of an elastic model shows that the original shock wave is severely modified by the development of new wave fronts and wavelets, and that localized, potentially destructive stress concentrations are generated by intersecting wave fronts, differential motions at discontinuous boundaries and interfaces, and overlapping of an incident wave and its reflected counterpart.—MS

01877 **Ritchie, Arthur S.** Recent advances in the chromatographic analysis of geologic materials, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 427-435, tables, 1969.

Recent advances in the following branches of the chromatographic analysis of geologic materials are discussed: (1) paper chromatography, (2) thin layer chromatography, (3) ion-exchange chromatography, and (4) gas chromatography.—KAF

07407 **Roberts, Wayne A.** Shock crater ejecta characteristics, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 101-114, illus., 1968.

The genetic stratigraphy (layering related to the mechanism of formation of ejecta units) of the outer lip of the Sedan crater in the Nevada Test Site exhibits characteristics similar to those of mapped ejecta units of the outer lip of Meteor Crater near Winslow, Arizona. In general, the ejecta deposits are wedge-shaped and thin radially outward. Their extent is a function of shock-imparted ejection angles and velocities, modified by gravity and atmospheric drag. Vertical separation into layers partly reflects winnowing and other influences of the atmosphere present.—MS

Robertson, J. K. *See* Lambert, I. B. 01719

07489 **Robertson, P. B.; Dence, M. R.; Vos, M. A.** Deformation in rock-forming minerals from Canadian craters, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 433-452, illus., tables, 1968.

Progressive changes in strain patterns recognized in quartz and feldspar involve a brittle fracture stage followed by successive stages of development of planar features and a final stage of general changes in optical properties culminating in an isotropic condition free of planar features. The transformations leading to isotropic feldspar apparently take place over a much smaller interval than the equivalent transformations in quartz. The deformation features are attributed to shock loading at low to moderate pressures and are considered evidence for a meteoritic impact origin for the 12 craters from which rock samples were studied.—MS

Robertson, P. B. *See* Dence, M. R. 07503

07354 **Robison, Richard A.** Unusual Middle Cambrian fossils from northern Utah [abs.]: Utah Acad. Sci., Arts and Letters Proc., v. 45, pt. 1, p. 320-321, 1968.

07501 **Roddy, David J.** The Flynn Creek crater, Tennessee, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 291-322, illus., 1968.

It is concluded that the Flynn Creek crater was produced by a shock-wave mechanism. The drill core evidence for a shallow lower boundary of the breccia lens and the decrease of deformation in the rocks below the breccia lens are consistent with an origin involving surface deformation, i.e., a meteorite or cometary impact. The thin breccia lens, the absence of mineralization, volcanic, or meteoritic materials, the types of rim deformation, and the central uplift are interpreted as consistent with the impact of a cometary body.—*from* Author's abstract

02019 **Rodgers, John.** Gnathostomulida—Is there a fossil record? [discussion of paper by R. J. Riedl, 1969]: Science, v. 164, no. 3881, p. 855-856, 1969.

Riedl's description (ibid., v. 163, no. 3866, p. 445-452, 1969) suggests that members of the new phylum Gnathostomulida are survivors of the group represented by the conodonts. Conodonts may be the hard parts of a group (order, class?) or groups of the phylum Gnathostomulida that developed phosphatic jaw parts and were hence enabled to grow somewhat larger, but that became extinct during the Mesozoic whereas the groups without such hard parts survived to the present.—DBV

Rogers, John J. W. *See* Cook, Beverly Gatlin. 07462

01583 **Rona, Peter A.** Comparison of continental margins off Northwest Africa and Cape Hatteras [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 738-739, 1969.

01754 **Rondeel, H. E.** On the nucleation of kink bands, *in* Research in tectonics: Canada Geol. Survey Paper 68-52, p. 363-365, 1969.

A model is outlined which represents the initiation of a kink nucleus and its longitudinal propagation in an ideally foliated, homogeneous body in which the material outside a kink band remains undeformed. The deformation can take place within the latter domain and the foliation usually becomes rotated, an event which seems to depend upon the conditions of confinement and restraint. The process of nucleation cannot be altered since the accompanying deformations are very small. The ends of most kink layers are wedge-shaped and the orientation of the planes changes and progressively more material is involved in a kink nucleus. The kink nuclei can be formed under strongly varying conditions.—HRC

01578 **Roots, Ernest F.** Arctic margin of Canada [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 739, 1969.

Rosenberg, J. Thomas. *See* Ahrens, Thomas J. 07402

Ross, G. J. *See* Brydon, J. E. 07431

01875 **Rostad, O. H.** The use of geochemistry at the Bald Butte molybdenite prospect, Lewis and Clark County, Montana, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 437-449, illus., 1969.

Geochemical soil sampling at the Bald Butte molybdenite prospect led to the discovery of interesting molybdenite mineralization associated with an unexposed porphyry intrusive. The area is not marked by bleaching or limonitic discoloration but is outlined by the 10-ppm Mo contour. The Mo anomaly as outlined by soil samples coincides well with anomalous Mo values in bedrock. The generally low-level anomalous values were obtained from the minus 35-mesh fraction of the soil samples. A comparison of results for soil and rock samples indicates Mo leaching; whereas, under the slightly acid pH conditions prevailing, Mo values would be expected to be generally fixed in place. It is suspected that this leaching is due to a shift in the Mo stability field caused by significant amounts of Ca.—*from* Author's abstract

01579 **Roy, Kenneth J.** Selective dolomitization of stromatolites [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 739, 1969.

01997 **Rucklidge, John.** Frohbergite, montbrayite, and a new Pb-Bi telluride: Canadian Mineralogist, v. 9, pt. 5, p. 709-716, illus., tables, 1969.

The composition of frohbergite, $FeTe_2$, has been confirmed from the original locality at Robb Montbray, Quebec, and electron probe studies have revealed new associations with chalcopyrite and melonite. Frohbergite has also been found in material from Noranda, Quebec, and Lindquist Lake, B.C. Montbrayite has been analyzed, and found to contain small but probably essential amounts of Bi and Pb.—Author's abstract

02012 **Rucklidge, John.** Electron microprobe investigations of platinum metal minerals from Ontario: Canadian Mineralogist, v. 9, pt. 5, p. 617-628, illus., tables, 1969.

Minute grains of minerals containing significant concentrations of the platinum metals Pd, Pt, Rh and Ir have been found associated with nickel ores from Werner Lake, Strathcona, and Falconbridge, Ontario. These grains have been analyzed by electron-probe methods and three species with the formulae $(Pd,Ni,Pt)(Te,Bi)_2$, RhAsS and IrAsS have been identified. The presence of major amounts of Ni in the first distinguishes it from other bismuthotellurides of the platinum metals. The latter two phases may be identified as hollingworthite and irarsite, both of which have only recently been described from South Africa. Between the two intergrown sulpharsenide phases all of the Pt metals are found, with the heavier ones concentrated in irarsite, and the lighter in hollingworthite. The presence of Ni in the platinoid bismuthotellurides may have genetic implications.—Author's abstract

07375 **Rudberg, Sten.** Wind erosion—Preparation of maps showing the direction of eroding winds: Biul. Peryglacjalny, no. 17, p. 181-193, illus., 1968.

Consequences of wind activity in the Swedish mountains are discussed. Most important is snow drift, but wind erosion of the ground is also important in some areas. The author has dealt with two problems of wind activity: distribution of wind eroded surfaces, and here the direction of eroding wind, including the method of mapping the wind direction by means of the erosion features on the ground. The most important features are scars in the vegetation, distribution of lichens on boulders, and shrub vegetation on lee sides. Two maps from the Swedish mountains are compared with a third from Axel Heiberg Island, Arctic Canada [geometrically the most simple wind system]. The influence of gravity seems to be high in all the maps.—*from* Author's abstract

Ruhe, R. V. *See* Walker, P. H. 07438

07440 **Ruhe, R. V.; Walker, P. H.** Hillslope models and soil formation—[Pt.] 1, Open systems [with French and German summ.], *in* Internat. Cong. Soil Sci., 9th, Adelaide, Australia, 1968, Trans., V. 4: New York, American Elsevier Publishing Co., p. 551-560, illus., tables, 1968.

Various slope-profile components in low-order valleys are defined. Hillslope-eroded debris may be partly trapped in valley fill and removed from open systems; sedimentation and erosion records are incomplete, but chronologic and environmental histories may be determined for the remainder. Curve fitting, using empirical equations or mathematical scaling and direct determination of algebraic form components, permits construction of hillslope models along slope profiles that are multidimensional by more complex analytical techniques. In the model, effects of erosion, sedimentation, time and environment on soil formation and in the soils *per se* are better understood. This approach in loess watersheds of southern Iowa shows universality in principle of hillslope models and soil systems, even though geomorphic and pedologic parameters differ; discordant subsets in Adair and Harrison Counties indicate lateral mergence of two geomorphic surfaces.—GDC

01873 **Ruotsala, Albert P.; Nordeng, Stephen C.; Weege, Randall J.** Trace elements in accessory calcite—A potential exploration tool in the Michigan Copper District, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 451-455, illus., table, 1969.

In an effort to establish an exploration tool for use in the lava series-conglomerate area in Houghton and Keweenaw Counties, Michigan, trend-surface analysis of trace elements in ore minerals and accessory minerals was attempted. Calcite was chosen as the accessory mineral to be used because of its wide distribution, its close relationship with Cu mineralization in time, and its relative ease of dissolution. Statistical correlation showed that Mn in calcite most nearly correlated with ore-grade native Cu mineralization, and that concentration of Mn in native Cu and calcite showed similar trends.—KAF

07345 **Rush, F. Eugene.** Water-resources appraisal of Thousand Springs Valley, Elko County, Nevada: Nevada Div. Water Resources, Water Resources—Reconn. Ser. Rept. 47, 61 p., illus., tables, 1968.

The sparsely populated Thousand Springs Valley is divided into four hydrologic segments through which Thousand Springs Creek flows. Carbonate rocks, abundant throughout, and alluvium may transmit between segments substantial parts of the valley's water resources. Sampled well and surface waters were generally chemically suitable for irrigation in the three western segments, but samples collected in Montello Valley were more highly mineralized.—MCM

02015 **Sabina, Ann B.; Jambor, J. L.; Plant, A. G.** Correction [to "Weloganite, a new strontium zirconium carbonate from Montreal Island, Canada," 1968]: Canadian Mineralogist, v. 9, pt. 5, p. 654, 1969.

An omitted unit in the formula of weloganite, and an item from the list of references, are added.—ESL

Sacks, I. S. *See* James, D. E. 01966

01580 **Sahu, Basanta K.** Correlation theory between thin-section and loose-grain arithmetic mean sizes on number-frequency basis [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 739-740, 1969.

Sampey, D. *See* MacLiver, C. N. 01869

01605 **Sandberg, Phillip A.; Plus-Quellec, Paul L.** Scanning electron microscopy of normal pores in cytheracean Ostracoda [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 740, 1969.

Sanders, John E. *See* Allen, Robert C. 01825

Sanders, John E. *See* Burger, John A. 01844

07353 **Sanders, John E.; Emery, K. O.; Uchupi, Elazar.** Side-looking sonar surveys of the Atlantic continental shelf [abs.], *in* National symposium on ocean sciences and engineering of the Atlantic Shelf, Philadelphia, 1968, Trans.: Washington, D.C., Marine Technology Soc., p. 299, 1968.

01828 **Savage, E. Lynn.** Ultrasonic disaggregation of sandstones and siltstones: Jour. Sed. Petrology, v. 39, no. 1, p. 375-378, table, 1969.

A probe type device used on selected Triassic continental sandstones, siltstones, shales, and several other rock types is described. The average time needed to disaggregate samples was much less for those treated with the probe sonifier than the tank-type of sonifier. Sandstones average 25 minutes per sample as compared with 13 minutes for shales and 58 minutes for the siltstones. Limestones or marbles take considerably longer with very poor results unless they are calcarenites in which the fragments are well separated by clay minerals. The probe device may also be used at the beginning of a hydrometer or pipette analysis of clays in lieu of overturning the graduated cylinder or stirring with other devices. If flocculation occurs after the test has begun, the probe may be inserted directly into the cylinder and run for 5-10 minutes.—*from* Author's abstract

Schink, David R. *See* Fanning, Kent A. 02031

01974 **Schlanker, Charles M.; Leisman, Gilbert A.** The herbaceous Carboniferous lycopod *Selaginella fraiponti* comb. nov.: Bot. Gaz., v. 130, no. 1, p. 35-41, illus., table, 1969.

A coal ball from southeastern Kansas has yielded a specimen of *Selaginella crassicinctus* Hoskins and Abbott attached to the stem *Paurodendron fraiponti* (Leclerq) Fry. New information concerning some of the various organs of this plant is offered. The entire plant is given the taxonomic designation *Selaginella fraiponti* (Leclerq) comb. nov. and is believed to be closely related to the extant taxon *Selaginella selaginoides*.—Authors' abstract

01836 **Schmalz, Robert F.; Swanson, Frederick J.** Diurnal variations in the carbonate saturation of seawater: Jour. Sed. Petrology, v. 39, no. 1, p. 255-267, illus., tables, 1969.

Cycles of pH, dissolved CO_2, and carbonate saturation in seawater are described. They result from changing rates of the opposing reactions respiration and photosynthesis. In carbonate environments, the increased activity of the dissolved CO_2 during the hours of darkness favors solution of solid carbonate phases in contact with the waters, and may lead to chemical erosion of consolidated carbonate rocks. During the daylight, the photosynthetic extraction of CO_2 reduces the solubility of carbonate phases, and leads to supersaturation of affected waters. The amplitude of the daily change in carbonate saturation equals or exceeds the lateral variations reported in earlier synoptic studies, and therefore casts doubt upon the validity of the synoptic studies now available.—*from* Authors' abstract

01859 **Schmalz, Robert F.** Deep-water evaporite deposition—A genetic model: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 4, p. 798-823, illus., tables, 1969.

Many features of ancient evaporite deposits are difficult to reconcile with the "salina" model of shallow, slowly subsiding basins in arid or semiarid climatic regions. An alternative "deep-basin" model of evaporite deposition appears to better explain inferred sedimentation rates, thickness of salts, petrography, stratigraphy, bromine content of salt, and the depositional history of several ancient evaporite deposits such as the Zechstein, Salina, Castile, and part of the Elk Point evaporites of Alberta.—EGS

Schmelz, Damian V. *See* Lindsey, Alton A. 02040

01606 **Schneider, E. D.** Evolution of continental margin [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 740, 1969.

Schneider, Eric D. *See* Heezen, B. C. 07350

Schneidermann, N. *See* Reiss, Z. 01848

02024 **Schnitker, Detmar.** *Cibicides, Caribeanella* and the polyphyletic origin of *Planorbulina*: Cushman Found. Foram. Research Contr., v. 20, pt. 2, p. 67-69, illus., 1969.

In material from the North Carolina continental shelf, the genus *Caribeanella* develops from a *Cibicides*-like juvenile form and, in turn, gives rise to a planorbulinid form. These *Planorbulina* differ from material from the Mediterranean and from forms described by Nyholm (1961) and S. C. Cooper (1965). It is assumed that the genus *Planorbulina* is of polyphyletic origin.—Author's abstract

Scholl, David W. *See* vonHuene, Roland E. 01586

01607 **Scholl, David W.; vonHuene, Roland E.** Geologic implications of Cenozoic subsidence and fragmentation of continental margins [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 740-741, 1969.

07389 **Scholten, R.** Model for evolution of Rocky Mountains east of Idaho batholith: Tectonophysics, v. 6, no. 2, p. 109-126, illus., 1968.

A gravitational model is presented, which assumes gliding movement away from an undation in the Idaho Batholith area, to provide the energy source for orogenic processes in the northern Rocky Mts. Late Cretaceous to Paleocene folds and thrusts east of the batholith are the result of compressive shortening compensating for extension in the domed roof due to down-flank gravitative spreading. Compressive stress propagated toward the cratonic shelf edge as earlier thrusts were folded and locked and newer thrusts formed farther east; local uplifts gave rise to epidermal gliding sheets. Boulder Batholith in Montana played a similar role. The model agrees well with radial tectonics around the northeastern Idaho Batholith, dominant westward transport on the Pacific side of the Cordilleran belt, and recent seismic data indicating the sial lacks a root and is thinner than normal by 5-20 km.—*from* Author's abstract

Scholz, C. H. *See* Brace, W. F. 01729

01736 **Scholz, C. H.; Wyss, M.; Smith, S. W.** Seismic and aseismic slip on the San Andreas fault: Jour. Geophys. Research, v. 74, no. 8, p. 2049-2069, illus., tables, 1969.

It is shown that the central section of the San Andreas fault is an extremely weak zone and that its strength is approximately that required for stick-slip friction. The 1966 Parkfield earthquake was deduced to be a dislocation about 4 to 10 km in depth that underwent a slip of 30 cm. As a result, stress concentrations about the fault produced creep and aftershock sequences, which are two independent facets of time-dependent frictional sliding. These two phenomena are compatible with laboratory friction experiments and with a creep rupture theory of aftershocks. One feature not observed in the laboratory is the episodic nature of creep. These episodes can be predicted with an accuracy of about one week.—KAF

01608 **Schroeder, Johannes H.; Siegel, Frederic R.** Experimental dissolution of calcium, magnesium, and strontium from Holocene biogenic carbonates—A model of diagenesis [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 741, 1969.

Schumann, H. H. *See* Brown, S. G. 01981

01609 **Schumm, S. A.** Paleochannels [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 741, 1969.

01824 **Schwab, Frederic L.** Geosynclines—What contribution to the crust?: Jour. Sed. Petrology, v. 39, no. 1, p. 150-158, illus., tables, 1969.

Estimates of the chemical composition of geosynclinal assemblages are made by converting detailed petrographic mineral analyses of individual samples into published chemical equivalents. While marginal geosynclinal basins, of which the Jackson, Wyoming, section is representative, do not appreciably differ from the composition of miogeosynclines, they exhibit very detailed changes vertically in composition and lithological proportion. Miogeosynclinal sediments differ greatly from the average sediment, and represent concentrations of CaO, MgO, CO_2, and H_2O. Considerable amounts of silica and alumina reflect the importance of intrageosynclinal terrigenous sources. Eugeosynclinal sediments, at first approxima-

tion, approach the average composition of igneous rocks, though silica is slightly enriched.—Author's abstract

02001 **Schwarz, E. J.** Thermomagnetic analysis of some red beds: Earth and Planetary Sci. Letters, v. 5, no. 5, p. 333-338, illus., 1969.

Analyses of red beds from the Precambrian of England and the Paleozoic of eastern Canada show that significant amounts of magnetite are generated if these samples are heated either in partial vacuum or in nitrogen. Only a small amount is generated if analyses are in air and subsequently in partial vacuum. In that case, one of the essential ingredients is inactivated at a temperature below that (about 400°C) at which magnetite production becomes noticeable on the time scale of the experiments. In the thermal demagnetization of red bed samples, the formation of magnetite can almost be avoided by heating in air of atmospheric pressure. The shape of the NRM decay curve obtained by heating the samples in air cannot be associated with either the occurrence of magnetochemical changes at higher temperatures or the presence of minerals with Curie points above 20°C other than hematite and, in some cases, magnetite.—*from* Author's abstract

07458 **Sclar, Charles B.; Short, Nicholas M.; Cocks, George G.** Shock-wave damage in quartz as revealed by electron and incident-light microscopy, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 483-493, illus., 1968.

Planar features observed in quartz from coesite- and stishovite-bearing Coconino Sandstone from Meteor Crater (Arizona) and other quartz samples that had a known or presumed shock history are interpreted as brittle fractures resulting from tensile pressures associated with rapid decompression in the waning stages of a shock event.—MS

Scoffin, Terence P. *See* Neumann, A. Conrad. 01617

07443 **Scott, Alan J.** Environmental factors controlling oyster shell deposits, Texas coast, *in* Forum on geology of industrial minerals, 4th, Austin, Tex., 1968, Proc.: Austin, Tex., Univ. Texas Bur. Econ. Geology, p. 129-150, illus., table, 1968.

The development of large oyster reefs is affected by a complex interrelationship of environmental and geological factors. *Crassostrea* is sedentary and so requires a firm, stable substrate and currents to bring food and carry away waste. These factors determine the shape and location of the reefs. A more effective exploration program could be developed based upon a knowledge of the environmental tolerance of oysters, the geologic and depositional history of the area, and an analysis of cores to determine paleoenvironmental conditions.—*from* Author's abstract

Scott, G. R. *See* Izett, G. A. 01761

01708 **Secor, Donald T., Jr.** Mechanics of natural extension fracturing at depth in the Earth's crust, *in* Research in tectonics: Canada Geol. Survey Paper 68-52, p. 3-47, illus.; discussion, p. 48, 1969.

The formation of a joint is a slow process consisting of numerous short quick episodes of fracture propagation interspersed with longer periods of quiescence during which pore fluid from the surrounding rock percolates into the crack and wedges it open. The growth rate depends upon the rate of percolation. The length of the joint is controlled by the ductility at the crack tip, and other joints. The fluid volume comes from both the elastic expansion of the ambient pore fluid and from the closure of other non-propagating cracks and flaws. The geometry of a particular joint set is probably related to rock permeability and to the rate of decrease of the least effective principal stress at the time of fracturing.—*from* Author's abstract

Semenov, E. I. *See* Perrault, Guy. 02010

01610 **Shepard, Francis P.** Relation of submarine canyons to continental slope [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 741-742, 1969.

Sherwood, C. B. *See* McCoy, H. J. 07386

01950 **Shideler, Gerald Lee.** Petrography and provenance of the Johns Valley boulders, Ouachita Mountains, southeastern Oklahoma and southwestern Arkansas [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3366B, 1969.

07422 **Shlichta, P. J.** The influence of dislocation-strain energy on crystal morphology, *in* Internat. Mineralog. Assoc., 5th Gen. Mtg., Cambridge, England, 1966, Papers and Proc.: London, Mineralog. Soc., p. 13-19, illus., 1968.

Analyses are presented of three different models of crystal growth, which assume isotropic surface-energy parameters. These analyses indicate that dislocation-strain energy can affect growth rate. There is ample evidence, however, that surface energy parameters usually have the predominant role in determining crystal growth rate and morphology and that dislocation-strain energy has only a minor effect. None the less, any detailed theory of crystal growth must take this factor into account.—Author's abstract

07476 **Shoemaker, Eugene M.** Structure of the Jangle U and Teapot Ess nuclear explosion craters [abs.], *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 627-628, 1968.

07497 **Short, N. M.; Bunch, T. E.** A worldwide inventory of features characteristic of rocks associated with presumed meteorite impact structures, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 255-266, illus., table, 1968.

Data on general characteristics and petrographic features of structures produced by meteorite impact or some other shock-producing process are presented in tables and discussed, together with photomicrographs of certain petrographic shock features about which there is little published information as yet.—MS

Short, Nicholas M. *See* French, Bevan M. 07404

Short, Nicholas M. *See* Sclar, Charles B. 07458

07483 **Short, Nicholas M.** Petrographic study of shocked rocks from the Steen River structure, Alberta, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 374-378, illus., 1968.

The petrographic characteristics of five samples from the Steen River structure and the orientation of planar sets in quartz of two of the samples are reported. The samples apparently fall into the same class of rocks as those from the Clearwater Lakes, Ries, and other structures generally described as meteorite impact structures, but the evidence is not completely conclusive for impact origin.—MS

07493 **Short, Nicholas M.** Nuclear-explosion-induced microdeformation of rocks—An aid to the recognition of meteorite impact structures, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 185-210, illus., table, 1968.

On the premise that resultant shock effects of underground nuclear explosions on the containing medium exhibit similarities to shock effects of rocks from meteorite impact structures, petrographic features of rock samples from nuclear explosion sites in rock salt, basalt, granite, and alluvium are reported, with reference to their significance for defining levels of stress and heat generation. Some of the effects are apparently exclusively due to the action of shock waves rather than any other known geologic process.—MS

07495 **Short, Nicholas M.** Experimental microdeformation of rock materials by shock pressures from laboratory-scale impacts and explosions, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 219-241, illus., tables, 1968.

The technique and results of four different methods of controlled shock experiments on rocks and minerals are reported. Observed effects have also been observed in rocks shock-loaded by nuclear explosions and meteorite impacts.—MS

Siegel, F. R. *See* Pierce, J. W. 01958

Siegel, Frederic R. *See* Schroeder, Johannes H. 01608

Siegel, Frederic R. *See* Stone, Irving C., Jr. 01839

Simmons, A. Barlow, 3d. *See* Morrow, Norman R. 01811

Simmons, Gene. *See* Chung, D. H. 01720

Simoneit, Bernd R. *See* Han, Jerry. 01979

Simons, P. Y. *See* Dachille, Frank. 07464

Singh, S. Shah. *See* Brydon, J. E. 02013

01903 **Skoch, Edwin James.** Seasonal changes in phosphate, iron, and carbon occurring in the bottom sediments, near Rattlesnake Island, in western Lake Erie, 1966 to 1968 [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3551B, 1969.

01858 **Sloss, L. L.** Evaporite deposition from layered solutions: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 4, p. 776-789, illus., table, 1969.

Synchronous carbonate and evaporite deposition from density-layered waters is an alternative explanation to the multistage concept of separate deposition of these rocks. An upper layer of nearly sea-water salinity from which carbonates may be deposited and a lower evaporite salt-saturated layer(s) with evaporite deposition are postulated. Such layered solutions may persist for geologically significant lengths of time. Episodic exposure of the lower brine is required for evaporite deposition and may result from displacement of the upper layer by wind or may accompany seiche activity. Examples of these processes are demonstrable in modern saline lakes and a laboratory model.—EGS

01843 **Smit, David E.; Swett, Keene.** Devaluation of "dedolomitization": Jour. Sed. Petrology, v. 39, no. 1, p. 379-380, 1969.

Recent literature (Evamy, 1967, and de Groot, 1967) has perpetuated the use of the term dedolomitization. The use of this term (1) requires multiple terminology for a single replacement process, (2) is inconsistent with nomenclature for other replacement processes, (3) is ambiguous, and (4) is geochemically misleading. The authors feel that a replacement process should be named by the replacing mineral, not the one being replaced.—Authors' abstract

Smith, A. Y. *See* Dyck, Willy. 01882

02004 **Smith, D. G. W.; Westgate, J. A.** Electron probe technique for characterizing pyroclastic deposits: Earth and Planetary Sci. Letters, v. 5, no. 5, p. 313-319, illus., tables, 1969.

Samples of Mazama Ash (6600 years old) from northwestern U.S.A. and southwestern Canada were used to test the compositional variability of clear, unaltered glass shards. The electron-probe analyses show that the glass composition is remarkably consistent, even though some sample locations are several hundred miles apart. The glass composition of Glacier Peak Ash (about 12,000 years old), St. Helen's 'Y' Ash (about 3000 years old) and Bridge River Ash (about 2500 years old) were also determined and found to be distinctive. Si, Ti, Al, Fe, Mn, Ma, Ca, Na, K, P, Cl, and F were determined to investigate the usefulness of each in characterizing these ashes. It was found that as few as three key elements, for example, Ca, K, and Fe, or Ca, K, and Na, serve to identify any one of these ashes.—*from* Authors' abstract

02022 **Smith, D. G. W.** Pyrometamorphism of phyllites by a dolerite plug: Jour. Petrology, v. 10, no. 1, p. 20-53, illus., 1969.

Thermal metamorphism of Dalradian phyllites associated with emplacement of a Tertiary dolerite plug progressed from breakdown of micaceous minerals to development of rheomorphic granophyres and residual silica-poor rocks by in-situ melting of the phyllites. Major- and trace-element analyses of phyllites and their metamorphosed equivalents, basic igneous rocks, and granophyric bands, together with major-element analyses of the highly desilicated ferromagnesian residues, illustrate the effects of the various metamorphic stages.—MS

07362 **Smith, D. Ingle.** University of Bristol karst hydrology expedition to Jamaica: British Speleol. Assoc. Proc., no. 6, p. 31-32, 1968.

Problems investigated were in the field of limestone geomorphology. Major research fields were: studies of limestone solution, subterranean flow, and rainfall and stream discharge; local geologic mapping and sample collection; and measurements of the rate of surface limestone lowering in absolute terms using a micro-erosion gage. Relationships between types of limestone landform and lithology were marked, but solutional erosion rates are comparable from one lithology to another. A complex pattern of flow lines was established. About 27,500 feet of cave passage was explored, mostly new discoveries.—ESL

Smith, Eugene I. *See* Elston, Wolfgang E. 07500

07392 **Smith, H. T. U.** "Piping" in relation to periglacial boulder concentrations: Biul. Peryglacjalny, no. 17, p. 195-204, illus., 1968.

Concentrations of bare boulders in formerly periglacial areas are attributed, in part, to their rearrangement by frost-induced sorting, and secondary denudation of removal of fines. The concept of piping, a term used in engineering to designate removal of materials by underground waters, appears to apply in boulder fields. Observations in uplands of the Beartooth Mts., Wyo.-Mont., in accord with interpretations for other areas, further support the piping hypothesis. The various types of boulder clusters are described, distinguishing between effects of different processes. Piping can explain removal of fines in situations and to depths otherwise difficult to account for, and contributes to the understanding of hitherto obscure aspects of periglacial features. Its initiation may be related perhaps to melting of periglacial ground-ice wedges and integration of resulting openings.—GDC

Smith, J. V. *See* Stephenson, D. A. 07429

01746 **Smith, James W.; Green, Martha A.** Large granitic exposures in Georgia [abs.]: Georgia Acad. Sci. Bull., v. 27, no. 2, p. 93, 1969.

01574 **Smith, Mark K.** Developments in seismic processing for geologic interpretation [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 742, 1969.

Smith, S. W. *See* Scholz, C. H. 01736

07371 **Smith, Stephen V.; Dygas, Joseph A.; Chave, Keith E.** Distribution of calcium carbonate in pelagic sediments: Marine Geology, v. 6, no. 5, p. 391-400, illus., tables, 1968.

Statistical analysis of 1,350 pelagic sediment samples indicates that on a worldwide basis water depth correlates poorly with $CaCO_3$ percentage of sediments. When nearshore data are excluded to remove the effects of clastic influx, correlations between percent $CaCO_3$ and depth improve, raising the correlation to -0.620, meaning that water depth predicts about 40 percent of the variability in $CaCO_3$ percentage of pelagic sediments. Neither variations in CO_2 concentration nor supposed rates of inorganic $CaCO_3$ solution appear to be satisfactory explanations for this moderate correlation. We suggest that adsorbtion of organic molecules to carbonate particles may prevent or inhibit carbonate-sea water interactions.—*from* Authors' abstract

Smith, T. J. *See* Steinhart, J. S. 01967

01575 **Snead, Robert G.** New approach to classification of *Azolla* megaspores species [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 742, 1969.

07382 **Sörensen, Henning.** På spor af sjældne metaller i Sydgrönland—[Pt.] 7, Zirconium, et af fremtidens metaller [with English abs.]: Grönland 1968, no. 12, p.353-365, illus., tables, 1968.

Eudialyte is of widespread occurrence in the peralkaline nepheline syenites of the Ilímaussaq intrusion, South Greenland. Ilímaussaq is the type locality for this mineral. Exploitation attempts of the eudialyte-carrying rocks were made in 1888, 1899 and 1946 but these attempts were not successful. In the summer of 1968 a new series of geological and technical examinations of the eudialyte-rich rocks was commenced in the kakortokites and naujaites. These rocks may contain more than 25 percent eudialyte. The role of zirconium and hafnium in modern technology is reviewed.—Author's abstract

01593 **Spencer, R. S.** Multivariate analysis of variance study of *Neochonetes granulifer* (Owen)—Its implication with respect to geographic variation and evolution [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 742, 1969.

Stacey, F. D. *See* Bhathal, R. S. 01732

01594 **Stanley, Daniel J.; Unrug, Rafael.** Coarse channelized deposits and other indicators of slope and base-of-slope environments in ancient marine basins [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 743, 1969.

Stanley, Daniel J. *See* Kelling, Gilbert. 01629

07376 **Stanley, Daniel J.; Kelling, Gilbert.** Sedimentation patterns in the Wilmington submarine canyon area, *in* National symposium on ocean sciences and engineering of the Atlantic Shelf, Philadelphia, 1968, Trans.: Washington, D.C., Marine Technology Soc., p. 127-142, illus., 1968.

The head of the canyon is acting as a sediment trap; movement of material down-axis to at least 500 fms is suggested. On the lower slope and rise, sediment types are silty in the vicinity of the canyon, and clayey on the open slope away from it. Gravel tongues on the east wall extend to 300 fms below shelf edge. Organisms play a dominant role in reworking sediments. Several dispersal trends are indicated: dominant westward supply of sand and silt to the canyon head; minor indications of southerly down-axis transport in the upper reaches; southwesterly transport on the outer part of the upper rise; and a northerly movement near the base of the slope. On the rise, erosion by bottom currents reveals slumped slabs. The occurrence of laminated layers only a few centimeters below bioturbated muds indicates that tranquil conditions may be more ephemeral than other evidence suggested.—*from* Authors' abstract

07381 **Stanley, Daniel J.; Cok, Anthony E.** Sediment transport by ice on the Nova Scotian Shelf, *in* National symposium on ocean sciences and engineering of the Atlantic Shelf, Philadelphia, 1968, Trans.: Washington, D.C., Marine Technology Soc., p. 109-125, illus., 1968.

Two of the three major forms of ice transport were influential during the Pleistocene. Morphology, sediment texture, and mineralogy indicate that continental glacial tongues modified landforms during major advances and contributed a thin sediment veneer, as far as the shelf edge in places. Outwash sediments are recognized on the outer banks of the northeastern shelf. By ice-rafting, bergs also extended the area of ice-borne sediment to the continental slope and rise. On the basis of mineralogy, all materials appear to have originated in areas northwest of the present coastline. Materials locally eroded from the shelf by glaciers contributed to the Quaternary cover. Since the Pleistocene, seasonal ice rafting on the northeastern margin has blanketed an area of pronounced relief. Processes controlled by bottom currents are modifying the relict sediment cover.—*from* Authors' abstract

01709 **Stearns, D. W.** Fracture as a mechanism of flow in naturally deformed layered rocks, *in* Research in tectonics: Canada Geol. Survey Paper 68-52, p. 79-90, illus., table; discussion, p. 91-95, 1969.

Cataclasis can be an active mechanism on all scales from grain to grain up to total sections thousands of feet thick. A given rock type can behave as a brittle member in one part of the structure and a ductile member in another part of the structure. The fracturing involved ranges from well ordered to completely unordered. Some of the parameters that seem to control cataclasis observed in natural studies are: rock type, total strain or strain rate, bedding thickness, degree of contrast in physical properties of adjoining layers, scale, and structural style. The most important control results from various combinations of these parameters.—*from* Author's abstract

07502 **Stearns, Richard G.; Wilson, Charles W., Jr.; Tiedemann, Herbert A.; Wilcox, John T.; Marsh, Phyllis S.** The Wells Creek structure, Tennessee, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 323-337, illus., 1968.

The Wells Creek structure is an intensely deformed concentric complex of annular fault blocks surrounded by flat-lying Mississippian strata. Although certain structural relationships, gravity and magnetic data, and the discontinuous stratigraphic distribution of breccias can be cited as evidence for origin of the structure by an endogenic mechanism such as a volcanic explosion, they can also be shown to support a meteorite impact origin, particularly in view of the orientation of shatter cones associated with the structure, whose development apparently requires intense shock-loading.—MS

01930 **Steidtmann, James Richard.** Sedimentation, stratigraphy and tectonic history of the early Eocene Pass Peak Formation, central-western Wyoming [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2944B-2945B, 1969.

Steiger, R. H. *See* Tilton, G. R. 01726

Steiner, Maureen B. *See* Helsley, Charles E. 02002

01967 **Steinhart, J. S.; Hart, S. R.; Smith, T. J.** Heat flow: Carnegie Inst. Washington Year Book 67, 1967-68, p. 360-367, illus., 1969.

Steinnes, E. *See* Brunfelt, A. O. 02009

07413 **Stephens, D. R.; Lilley, E. M.** Static P-V curves of cracked and consolidated earth materials to 40 kilobars, *in* Shock metamorphism of natural materials, 1st Conf., Greenbelt, Md., 1966, Proc.: Baltimore, Md., Mono Book Corp., p. 51-57, illus., tables, 1968.

Corresponding values of pressure-volume relationships of two basalts, mineralogically similar but with different densities, and their shock-produced cracked equivalents reveal two types of behavior with increasing pressure, related to porosity. Cracking of the less dense ("porous") material permits compression to a smaller volume (at constant pressure) than the solid; cracking the denser material produced a larger volume at equal pressure. The P-V curves are an important part of the equation of state of the rock in underground explosion sites.—MS

07429 **Stephenson, D. A.; Smith, J. V.; Howie, R. A.** X-ray powder diffraction data on orthopyroxenes [abs.], *in* Internat. Mineralog. Assoc., 5th Gen. Mtg., Cambridge, England, 1966, Papers and Proc.: London, Mineralog. Soc., p. 338, 1968.

01990 **Sternberg, Yaron M.** Some approximate solutions of radial flow problems: Jour. Hydrology, v. 7, no. 2, p. 158-166, tables, 1969.

Exact solutions to boundary value problems in ground-water flow have been solved in recent years using Laplace transformation. For most radial flow problems, the transform does not have a simple inverse and various methods such as the Mellin's

inversion formula must be employed. The resulting exact solution is frequently in form of a complex integral or an infinite series which is difficult to evaluate. An approximate inversion formula for Laplace transforms, developed for the solution of visco-elastic problems, is applicable to most radial flow problems. Three cases are considered: a well pumping a constant discharge from an infinite aquifer, a well pumping a constant discharge from an infinite leaky aquifer, and a well drawing an infinite leaky aquifer subject to constant drawdown.—*from* Author's abstract

01868 **Stevens, D. N.; Bloom, D. N.; Bisque, R. E.** Evaluation of mercury vapor anomalies at Colorado Central Mines, Clear Creek County, Colorado [abs.], *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 513-514, 1969.

07366 **Stevenson, Anne L.** A new technique for obtaining uniform volume sediment samples for pollen analysis: Pollen et Spores, v. 10, no. 2, p. 461-464, 1968.

A new technique for obtaining precise volumes of sediment samples has proven useful for pollen analyses of lacustrine and paludal sediment. A sample of definite volume is obtained by pressing the open end of one-half plain gelatin capsule into the sediment. The enclosing capsule is hydrolyzed in the subsequent chemical treatment schedule for fossil pollen preparation.—KAF

07380 **Stewart, Harris B., Jr.** Science, surveys, and the Continental Shelf, *in* National symposium on ocean sciences and engineering of the Atlantic Shelf, Philadelphia, 1968, Trans.: Washington, D.C., Marine Technology Soc., p. 3-7, 1968.

Scientific exploration of all types on the continental shelves and estuaries should include examination of problems of waste disposal, pollution, recreation areas, food supply, commerce, and navigation, especially in the estuaries. More detailed mapping, knowledge of the distribution of organisms and of sediments, and mineral resource evaluation are principal needs.—ESL

Stewart, J. M. *See* Petruk, W. 02011

01842 **Stieglitz, Ronald D.; Inden, Richard F.** Development of cavernous sediment in a non-beach environment: Jour. Sed. Petrology, v. 39, no. 1, p. 342-344, illus., 1969.

Vesicular or cavernous sediment covers much of the floor of the Cagle's Mill Dam spillway, southwest of Cloverdale, Ind. Caverns are best developed in the fine-grained sand and coarse-grained silt interlayered with coarse-grained sand and clay-rich material. They appear to have formed during heavy rains by entrapment of air below rapidly saturated surface layers and the consequent expulsion and concentration of bubbles in the sediment by downward movement of water. Several periods of heavy rainfall followed by drying, enlarged the features.—Authors' abstract

01595 **Stitt, James H.** Evolution of tribolite populations, Late Cambrian biomeres [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 743-744, 1969.

07477 **Stockwell, C. H.** Geochronology of stratified rocks of the Canadian Shield, *in* Geochronology of Precambrian stratified rocks—Internat. Conf., Edmonton, Alberta, 1967, Papers: Canadian Jour. Earth Sci., v. 5, no. 3, pt. 2, p. 693-698, illus., table, 1968.

In the Canadian Shield, four orogenies [Kenoran, Hudsonian, Elsonian, Grenvillian], serve to divide the succession into five natural time-stratigraphic units. These are named for convenience in mapping, description, and discussion. Rock units in type areas, rather than abstract time, form the basis for the classification. Isotopic dates place the geological units in a scale of years and are extremely valuable for the purpose of long range correlation.—Author's abstract

07355 **Stokes, William Lee; Balsley, John.** Supposed coprolites from the Ferron Sandstone of Utah [abs.]: Utah Acad. Sci., Arts and Letters Proc., v. 45, pt. 1, p. 320, 1968.

01839 **Stone, Irving C., Jr.; Siegel, Frederic R.** Distribution and provenance of minerals from continental shelf sediments off the South Carolina coast: Jour. Sed. Petrology, v. 39, no. 1, p. 276-296, illus., tables, 1969.

Heavy mineral suites from the shelf of South Carolina and from James Island are dominated by epidote, hornblende, and opaques; significant amounts of garnet, sillimanite, staurolite, tourmaline, actinolite, and kyanite are also present. Most are from the Piedmont province, but some resided temporarily in the coastal plain. No evidence for a source from the existing sediments of the continental shelf is reported. The light minerals are predominantly quartz and carbonate detritus. The clay fractions, kaolinite, illite, and montmorillonite, were present in quantities less than 1 percent in the shore and nearshore samples. No clays were found in the offshore samples; this is attributed to the "scrubbing" action of the marine currents reported to be active in the area.—*from* Authors' abstract

01951 **Straw, William Thomas.** Geomorphology, hydrogeology, and economic geology of the Ohio River Valley, Mauckport to Cannelton, Indiana [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3366B-3367B, 1969.

01596 **Stricklin, F. L., Jr.; Amsbury, D. L.** Middle Glen Rose (Lower Cretaceous) deposits of central Texas—A depositional model of shallow-water carbonate shelf [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 744, 1969.

01597 **Strimple, H. L.; Cocke, J. M.** Facies and faunal relations in Pennsylvanian Missourian rocks along Oklahoma-Kansas boundary [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 744, 1969.

01985 **Stulik, R. S.; Moosburner, Otto.** Hydrologic conditions in the Gila Bend basin, Maricopa County, Arizona: Arizona Land Dept. Water-Resources Rept. 39, 63 p., illus., tables, 1969.

Ground-water withdrawal in this basin has caused water-level fluctuations and changes in shape of the piezometric surface. Depth to water ranged from less than 50 to more than 350 feet in spring 1966. Rate of decline in the Rainbow Valley area has decreased since 1961, probably in response to decreased pumpage. Since 1953, water levels near Gila Bend have declined from 20 to 60 feet; in the Citrus Valley area they have risen. In 1965, about 115,000 acre-feet of ground water was pumped for agricultural use, and 500 acre-feet for domestic use. The mean annual surface-water inflow to the basin, 1960-65, was 15,390 acre-feet. During the flood of January 1966, 407,000 acre-feet of water passed Gillespie Dam, but only 255,000 passed Painted Rock Dam, 36 miles around the bend. Much of the flow loss probably went into ground-water storage.—GDC

Suhr, N. H. *See* Medlin, J. H. 01743

Sullivan, J. V. *See* MacLiver, C. N. 01869

Sutherland, J. K. *See* Hamilton, J. B. 07417

02038 **Swadley, W. C.** Geologic map of the Union quadrangle, Boone County, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-779, scale 1:24,000, section, text, 1969.

Sand in the glacial outwash of the Union quadrangle may be suitable for construction material. A show of oil has been reported in the St. Peter Sandstone. Ground water is hard to very hard and most drilled wells do not produce enough water for a dependable domestic supply. Shale of the Kope Formation slumps readily when wet. Big Bone area, a widely known collecting locality for Pleistocene mammals, is being developed as a state park.—MCM

Swanson, Frederick J. *See* Schmalz, Robert F. 01836

Swanson, Vernon E. *See* Ong, H. Ling. 01889

Swett, Keene. *See* Smit, David E. 01843

01956 **Swift, Donald J. P.; Heron, S. Duncan, Jr.; Dill, Charles E., Jr.** The Carolina Cretaceous—Petrographic reconnaissance of a graded shelf: Jour. Sed. Petrology, v. 39, no. 1, p. 18-33, illus., 1969.

Examination of shape of size distribution curves from size analysis of 140 samples permits classification into nearshore, proximal shelf, and distal shelf sands and shelf muds. Modal diameter plots against distance from the Cretaceous shoreline results in a triangular scatter with a well-defined upper limit of 3.5 phi. Nearshore samples range from 1.0 to 3.5 phi and grade outward to 3.5. A model is proposed whereby resuspension of bottom sediments by storms results in textural differentiation of nearshore sediment, and its movement seaward to replace sediment lost through deposition or bypassing over the shelf edge. Coarser sediment fractions are preferentially deposited nearshore, and the sediment becomes more homogeneous and finer grained in an offshore direction. The model conforms to the available data.—*from* Authors' abstract

Tailleur, Irvin L. *See* Brosge, William P. 01566

Taylor, Patrick T. *See* Zietz, Isidore. 07348

Taylor, R. W. *See* Kahn, J. S. 07473

07454 **Taylor, Ralph E.** Cap rock genesis and occurrence of sulphur deposits, *in* Forum on geology of industrial minerals, 4th, Austin, Tex., 1968, Proc.: Austin, Tex., Univ. Texas Bur. Econ. Geology, p. 69-79, illus., tables, 1968.

The anhydrite zone of cap rock of many shallower salt domes of the Gulf coast is a residual accumulation of disseminated anhydrite grains leached from the salt, associated with minor amounts of other distinctive water-insoluble mineral grains and rock fragments that also occurred in the salt. Anhydrite has altered to gypsum where suitable depth and time factors are present. Native sulfur and calcite altered from sulphates, anhydrite, and gypsum in the presence of hydrocarbons. Sulfur and calcite are direct replacements of the sulphates. Work with isotopes provides evidence that the sulfur-reducing bacteria which utilized the hydrocarbons were the alteration agents. Cap rock is the important source of sulfur in this country.—*from* Author's abstract

01751 **Taylor, Thomas N.** On the structure of *Bowmanites dawsoni* from the Lower Pennsylvanian of North America: Palaeontographica, ser. B, v. 125, nos. 1-3, p. 65-72, illus., 1969.

Bowmanites dawsoni of Lower Pennsylvanian age from eastern Kentucky provides additional information about the structure of this sphenophyllacean fructification. Specimens range from 1.5-4.3 cm long and consist of regularly-spaced whorls of bracts coalescent for part of their length to form a shallow disc. Two sporangiophores of unequal length arise from the upper surface of each bract close to the cone axis. Each sporangiophore bears a single sporangium directed back toward the cone axis in an anatropous position. The pattern of bract and sporangiophore vascularization is described. Kentucky cones are compared with specimens of *B. scotti* and an emended diagnosis for *B. dawsoni* is proposed. Relations with other structurally preserved species are discussed.—*from* Author's abstract

01599 **Tebbutt, Gordon E.** Diagenesis of Pleistocene limestone on Ambergris Cay, British Honduras [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 745, 1969.

Testa, Richard. *See* Mellor, Malcolm. 01809

Testa, Richard. *See* Mellor, Malcolm. 01851

01600 **Thomas, G. E.** Textural and reservoir variations of Ordovician microdolomites, Lake Alma-Beaubier oil-producing area, southern Saskatchewan [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 745, 1969.

02025 **Thomas, Jolly D.; Heidel, S. G.** Chemical and physical character of municipal water supplies in Maryland: Maryland Geol. Survey Rept. Inv. 9, 52 p., illus., tables, 1969.

The 65 largest public water supplies in Maryland deliver about 378 mgd of water to over 3 million people. More than 80 percent of these people, who use about 320 mgd, are supplied by either the Baltimore Bureau of Water Supply or the Washington Suburban Sanitary Commission. Sixteen municipal supplies use surface water, 43 use ground water, and 6 use both surface and ground water. Surface water serves more than 89 percent of the population, although more individual communities obtain supplies from ground water. Twenty-two public supplies reportedly add fluoride to their water and 10 supplies have natural fluoridation of 0.4 ppm or more. The treated water of most municipalities is soft or moderately hard, and only 7 facilities deliver finished water that is classified as hard, or very hard.—*from* Authors' abstract

01601 **Thompson, Allan M.** Clay-mineral diagenesis in redbed sequence, Juniata Formation, central Pennsylvania [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 745-746, 1969.

07361 **Thompson, P.** The caves and karst of Mexico: British Speleol. Assoc. Proc., no. 6, p. 45-51, illus., 1968.

The purpose of the paper is to make known the vast potential of Mexico as a region of very deep caves. The geology and characteristic karst features of the following caving areas are described: the Nuevo Laredo-Monterrey region, Sierra de Guatemala, Sierra de El Abra, Xilitla region, Huautla region, and Guerrero-Morelos region. Notable caves in each area are mentioned also.—ESL

01602 **Thomson, Alan.** Soft-sediment faults as indicators of paleoslope orientation [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 746, 1969.

Thorpe, R. I. *See* Harris, D. C. 02016

01603 **Thorstenson, Donald C.** Pore-water chemistry of carbonate sediments from Harrington Sound, Bermuda [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 746, 1969.

Tiedemann, Herbert A. *See* Stearns, Richard G. 07502

07390 **Tierney, F. Lyle; Billings, Marland P.; Cassidy, Martin M.** Geology of the City Tunnel, Greater Boston, Massachusetts: Boston Soc. Civil Engineers Jour., v. 55, no. 2, p. 60-96, illus., tables, 1968.

City Tunnel, part of a water supply system for Metropolitan Boston, extends east from Weston for 4.78 mi to Chestnut Hill Reservoir, where a short branch runs southeast. At depths of 233 to 446 feet, the tunnels cross the northern limb of the Central Anticline, entirely in bedrock (the Boston Bay Group and some 109 diabase dikes). The main tunnel cuts west to east, from youngest to oldest: gray argillites of the Cambridge Formation, 1160 feet; tillite for 1300 feet in the Squantum Member of the Roxbury Formation; 12,160 feet in clastics of the Dorchester Member and associated sheets of Brighton melaphyre; 10,639 feet, and the branch 3422 feet, in clastics of the Brookline Member. Beds dip gently north and northwest; strike of 251 joints averages N. 10° E.; that of faults, mostly minor, N. 30° E.; the dikes, 5 to 15 feet wide, dip steeply. Only 16 feet of the tunnel needed support.—GDC

01604 **Tillman, Roderick W.** Carbonate facies and paleogeography of Robinson Member, Minturn Formation, Eagle Basin, Colorado [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 746, 1969.

01726 **Tilton, G. R.; Steiger, R. H.** Mineral ages and isotopic composition of primary lead at Manitouwadge, Ontario: Jour. Geophys. Research, v. 74, no. 8, p. 2118-2132, illus., tables, 1969.

Granitic rocks at Manitouwadge, Ontario have an age of 2720 ± 50 m.y. based on isotopic Pb data and on whole rock Rb-Sr measurements. Pb from the ore body yields a model age of 3000 m.y., using an age of 4550 m.y. for the Earth and a closed-system evolution model for the Pb. Pb from ores across the Superior Province have isotopic compositions similar to that of the ore at Manitouwadge. Less complete data

from other continents suggest that ore Pb with model ages of 3000 m.y. are associated with rocks having radiometric ages of 2700 m.y. Several possibilities can explain the data: (1) the age of the Earth is not 4550 m.y.; (2) terrestrial primordial Pb did not have the same isotopic composition as Fe meteorite Pb; (3) isotopic evolution of Pb did not take place in a chemically closed system.—*from* Authors' abstract

07346 **Tixier, M. P.; Morris, R. L.; Connell, J. G.** Log-evaluation of low-resistivity pay sands in the Gulf Coast [abs.], *in* SPWLA Logging Symposium, 9th Ann., New Orleans, La., 1968, Trans.: Houston, Tex., Soc. Prof. Well Log Analysts, p. E1, 1968.

01989 **Toomey, Donald Francis; Mamet, B. L.** Annotated bibliography of Paleozoic nonfusulinid Foraminifera, Addendum 6: Cushman Found. Foram. Research Contr., v. 20, pt. 2, p. 45-64, 1969.

This addendum includes 116 annotated references pertaining to Paleozoic nonfusulinid Foraminifera, and can be considered reasonably complete through the year 1967. As in previous bibliographies (Toomey, 1959, 1961, 1963, 1965, 1966, and Toomey and Mamet, 1967, 1968), the aims are: (1) to summarize briefly the pertinent data contained in each article; (2) to list all new genera and species described therein; (3) to denote, within brackets, all taxonomic changes noted from current and subsequent publications and to include pertinent comments when possible, thus making the bibliography a more useful working tool.—Authors' abstract

Tooms, J. S. *See* Gregory, P. 01887

Tryggvason, Eysteinn. *See* Jam L., Pedro. 01625

01576 **Uchupi, Elazar; Emery, K. O.; Knott, S. T.; Bowin, C. O.; Phillips, Joseph; Prada, K. E.; Bunce, E. T.** Continental rise off east coast of North America—Shallow structure [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 746-747, 1969.

Uchupi, Elazar. *See* Bowin, Carl O. 01703

Uchupi, Elazar. *See* Sanders, John E. 07353

Ueda, S. *See* Kume, S. 01721

Unrug, Rafael. *See* Stanley, Daniel J. 01594

02007 **VanAndel, Tjeerd H.; Phillips, Joseph D.; VonHerzen, R. P.** Rifting origin for the Vema fracture in the North Atlantic: Earth and Planetary Sci. Letters, v. 5, no. 5, p. 296-300, illus., 1969.

The Mid-Atlantic Ridge crest is offset more than 300 km along the E-W trending Vema fracture valley. The trend of the extremities of this valley outside the region of recent earthquakes, as well as that of apparently inactive transverse valleys to the south, is somewhat south of east. These observations, and the fact that the valleys to the south apparently do not extend across the ridge crest, strongly suggest that a new pattern of ridge-growth and sea floor spreading, represented by the Vema fracture valley, has been superimposed on an older one. A geometrical model is proposed for the recent development of the Vema fracture valley, which is shown to be consistent with other geological and geophysical observations of this region.—Authors' abstract

01874 **VanTassell, Robert E.** Exploration by overburden drilling at Keno Hill Mines Limited, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 457-478, illus., tables, 1969.

The overburden drilling technique has successfully found veins by tracing float to its source in the deep overburden above the silver-rich veins in the Galena Hill-Keno Hill area in the central Yukon. Vein material can be recognized visually either in coarse material screened from the sample and(or) in the panned concentrate. By

using a combination of geochemical and visual information, a vein fault may be traced. Lead is the best geochemical indicator of a vein because its low solubility prevents any significant chemical migration of values beyond the float train.—KAF

VanVloten, Roger. *See* Outerbridge, William F. 07384

01866 **Varlamoff, Nicolas.** The bearing of tin minerals and ores in the weathering zone and the possibility of geochemical exploration for tin, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 479-495, illus., 1969.

Tin is derived from the alteration of granitic rocks, from the decomposition of tin sulfides, from the destruction of residual minerals such as varlamoffite, and from the finely grained fraction of cassiterite. It is mixed with soil obtained from the erosion of granitic rocks and associated metamorphics, which results in formation of local and regional geochemical anomalies for tin. From tin exploration in the Maniema region, Congo, under conditions of thick equatorial vegetal cover and very scarce granite outcrops, promising granitic intrusions may be detected easily by soil sampling.—KAF

01584 **Vidrine, Louis O.** Deep Miocene in southeast Louisiana [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 747, 1969.

01585 **Visher, Glenn S.** Physical characteristics of fluvial deposits [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 747, 1969.

VonHerzen, R. P. *See* VanAndel, Tjeerd H. 02007

01586 **vonHuene, Roland E.; Scholl, David W.** Tectonic implications of structures at base of Pacific continental margins [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 747-748, 1969.

vonHuene, Roland E. *See* Scholl, David W. 01607

VonMichaelis, H. *See* Ahrens, L. H. 01963

01964 **VonMichaelis, H.; Willis, J. P.; Erlank, A. J.; Ahrens, L. H.** The composition of stony meteorites—[Pt.] 1, Analytical techniques: Earth and Planetary Sci. Letters, v. 5, no. 6, p. 383-386, tables, 1969.

Details are given of the preparation of stony meteorite samples and of the X-ray fluorescence methods used for determining Fe, Si, Mg, Ca, Al, Ti, Mn, K, P, Zr, Sr, and Rb in the samples.—Authors' abstract

02021 **VonMichaelis, H.; Ahrens, L. H.; Willis, J. P.** The composition of stony meteorites—[Pt.] 2, The analytical data and an assessment of their quality: Earth and Planetary Sci. Letters, v. 5, no. 6, p. 387-394, illus., tables, 1969.

Quantitative data for Fe, Si, Mg, Al, Ca, Mn, Ti, K, P, Zr, Sr, and Rb in 48 chondrites and 6 achondrites are presented. Five of the chondrites and one achondrite have not been analyzed before. The quality (precision and accuracy) of the data are critically assessed.—Authors' abstract

07430 **vonReichenbach, H.; Rich, C. I.** Preparation of dioctahedral vermiculites from muscovite and subsequent exchange properties [with French and German summ.], *in* Internat. Cong. Soil Sci., 9th, Adelaide, Australia, 1968, Trans., V. 4: New York, American Elsevier Publishing Co., p. 709-719, illus., tables, 1968.

Muscovite was freed of K by extractions with $BaCl_2$ solution at 120°C, and portions of dioctahedral Ba-vermiculite produced were saturated with Na, Rb, Cs, Mg, Ca and Sr and equilibrated with Cl^- solutions of the respective cations. The isotopic exchange was studied in the equilibrated suspensions. For Na and Ca isotopic exchange between cations in solution and adsorbed cations was completed within

two hours. Even at 120°C, no provable exchange of interlayer -Rb and -Cs was observed within periods of four weeks. Chemical compositions and self-diffusion coefficients are tabulated; in contrast to trioctahedral vermiculite, lower rates in dioctahedral vermiculite are attributed to its higher charge density. Interrelated factors in the determination appear to be layer separation, layer charge, cation size, and hydration.—*from* Authors' abstract

01747 **Voorhies, M. R.** An Eocene sea cow tooth from Twiggs County, Georgia [abs.]: Georgia Acad. Sci. Bull., v. 27, no. 2, p. 93-94, 1969.

01748 **Vorhis, Robert C.** Depositional structure in the Georgia Coastal Plain [abs.]: Georgia Acad. Sci. Bull., v. 27, no. 2, p. 94, 1969.

Vos, M. A. *See* Robertson, P. B. 07489

Waagé, Karl M. *See* Rhoads, Donald C. 01573

01831 **Waite, J. M.** Anomalies in the thermoluminescence of the Austin Chalk of Texas—Reply to comment by McDougall: Jour. Sed. Petrology, v. 39, no. 1, p. 395, 1969.

McDougall (ibid.), suggests that an increase in thermoluminescence of the Austin Chalk in the Balcones fault zone area is due to strain. The author shows that the same rock has different thermoluminescent responses in the same outcrop and attributes the differences to impurity ion content.—HRC

Wakita, Hiroshi. *See* Nagasawa, Hiroshi. 02028

07438 **Walker, P. H.; Ruhe, R. V.** Hillslope models and soil formation—[Pt.] 2, Closed systems [with French and German summ.], *in* Internat. Cong. Soil Sci., 9th, Adelaide, Australia, 1968, Trans., V. 4: New York, American Elsevier Publishing Co., p. 561-568, illus., tables, 1968.

Areas of closed drainage, where products of erosion remain in the toeslope, occur in Iowa on Cary (late Wisconsin) drift, in bog watersheds subjected to erosion since ice retreat 13,000 years ago. Typical closed systems at Colo and Jewell are described; a model of the Clarion-Webster soil association shows stratigraphy and soil changes across the landscape. Sediment and soil data along transects at Jewell, showing systematic variation in particle size, stratum thickness, A-horizon properties, and lime profile, are fitted by polynomial trend equations well suited to show maxima and minima characteristics of closed systems; the better statistical fit in a smaller, more homogeneous closed system is noted. Given a soil landscape, stratigraphically controlled, and homogeneous parent material, the general form of sediment and soil trends for closed systems can be predicted and represented by trend equations.—*from* Authors' summary

Walker, P. H. *See* Ruhe, R. V. 07440

01587 **Walker, Roger G.** Ripple-drift cross-lamination in turbidites [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 748, 1969.

01931 **Wall, Robert Ecki.** Geophysical investigations in the central basin of Lake Erie [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2945B, 1969.

01727 **Walsh, J. B.** Dip angle of faults as calculated from surface deformation: J ır. Geophys. Research, v. 74, no. 8, p. 2070-2080, illus., 1969.

The ratio of absolute displacements of hanging and foot walls at the fault line is determined by the dip angle for faults intersecting the surface, and is independent of distribution of stress released at the fault surface and of whether motion is strike-slip or dip-slip, in most cases. Dip angles calculated from surface displacements for Tango, Idu, Niigata, San Francisco, and Imperial Valley earthquakes are consistent with values estimated from other data. For the Tango and the San Francisco earthquakes, decades elapsed between measurement periods, and the effect of tec—

tonic strain accumulation had to be considered for a correct interpretation of data. Rates of strain accumulation and release indicate that about 1000 years was required to build up the strain released in the Tango earthquake, and several hundred years for the San Francisco shock.—*from* Author's abstract

01588 **Wanless, Harold R.** Sedimentary structure zonation on tidal levees, Andros Island, Bahamas [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 748, 1969.

Wanless, Harold R. *See* El-Ashry, Mohamed T. 07369

01865 **Ward, F. N.; Nakagawa, H. M.** Atomic absorption techniques in geochemical exploration—Problem or progress, *in* International geochemical exploration symposium: Colorado School Mines Quart., v. 64, no. 1, p. 497-506, tables, 1969.

Detailed studies of atomic absorption measurements of a given element in geologic materials reveal severe interference from the other elements that are usually present, especially when the accompanying elements are present in large excess. Sample dissolution for atomic absorption methods is similar to that for wet chemical trace methods, and the interferences resulting from variations in matrix composition not only are present in the sample solution but are often unknown and unpredictable, and may preclude establishment of routine procedure.—*from* Authors' abstract

07461 **Ward, Porter E.; Wilmoth, Benton M.** Ground-water hydrology of the Monongahela River basin in West Virginia: West Virginia Geol. and Econ. Survey River Basin Bull. 1, 54 p., illus., tables, geol. map, 1968.

Ground water, adequate for present and future needs of this area, is obtained principally from extensive aquifers in sandstone. Areas most favorable are underlain by rocks of the Pottsville and Allegheny Groups, the Greenbrier Limestone, and Pocono Group. Other rock aquifers may be fair to good for moderate development. Alluvium along major streams is too thin and restricted for large development, although test drilling may reveal permeable sand and gravel beds in wider floodplains. Water quality is satisfactory for domestic and most other uses, except for high iron and, in a few places, objectionable hydrogen sulfide. Deeper wells in Devonian rocks, may yield saline water; shallow aquifers are contaminated by coal mining, oil- and gas-field brines, municipal sewage, chemicals and fertilizers.—GDC

01589 **Ward, William C.; Folk, Robert L.; Wilson, James Lee.** Surficial alteration of Pleistocene(?) limestone adjacent to saline lakes, Isla Mujeres, Quintana Roo, Mexico [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 748-749, 1969.

01590 **Warme, John E.** Live and dead mollusks in a coastal lagoon [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 749, 1969.

Wasserburg, G. J. *See* Bogard, D. D. 02018

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Watson, Richard L. *See* Behrens, E. William. 01833

Wayhan, D. A. *See* McCaleb, J. A. 01569

Webb, J. S. *See* Horsnail, R. F. 01888

01984 **Webb, S. David.** The Burge and Minnechaduza Clarendonian mammalian faunas of north-central Nebraska: California Univ. Pubs. Geol. Sci., v. 78, 191 p., illus., tables, 1969.

Of three successive late Miocene-middle Pliocene local faunas, the two younger, here described, are the Burge, from the Burge sands (top of Valentine Fm.), and the Minnechaduza, from the base of the Ash Hollow Formation. The Minnechaduza, which accumulated in ponds or marshes on a grass-covered floodplain, consists of plains-dwelling ungulates, mostly equids and camelids, some pond and, rarely, forest

mammals. The Burge fauna, similar but with an important forest element, was deposited in stream channels by seasonal floods. A new canid genus and species is described, two new mellivorine mustelid tribes and a new genus are diagnosed, and numerous revisions are made. The Clarendonian mammalian chronofauna of the Great Plains and Gulf Coast differs distinctly from contemporaneous faunas to the west.—VMJ

01716 **Weber, Jon N.** The incorporation of magnesium into the skeletal calcites of echinoderms: Am. Jour. Sci., v. 267, no. 5, p. 537-566, illus., tables, 1969.

The distribution of Mg in echinoderm calcite is a function of environmental and genetic factors. Systematic compositional variations occur within a single skeletal component, within the skeleton of a single animal, and within a single echinoderm population. The observations are consistent with a model based on the rate of calcification and amino acid compositional variations in the mineralizing organic matrix. Fossil echinoderms were found to contain only a few percent Mg in their skeletal calcite. Dolomitization of such skeletal material appears to be a rare event; recrystallization to the more stable low-Mg calcite is the most important diagenetic process.—*from* Author's abstract

Weege, Randall J. *See* Ruotsala, Albert P. 01873

Weiser, Daniel. *See* Moiola, R. J. 01622

01753 **Weiss, L. E.** Flexural-slip folding of foliated model materials, *in* Research in tectonics: Canada Geol. Survey Paper 68-52, p. 294-357, illus.; discussion, p. 358-359, 1969.

Small decks of thin, strong paper cards are shortened 55 to 37 percent parallel or oblique to the cards in an orthogonal press. Fold structures developed are found to depend mainly upon lateral load, and all structures can be explained in terms of 'conjugate kinking', a type of flexural slip folding involving planar slip between and within the cards. Typically, a progressively deformed specimen develops several generations of kink and conjugate kink folds, each subsequent generation having smaller amplitude than the last. In some, the sequence is interrupted by the development of a late major conjugate fold by selective lateral growth of kink layers. In none of the experiments are folds in the cards seen to develop entirely by gradual appression of initially 'open' folds.—*from* Author's abstract

Weissmann, S. *See* Braun, R. L. 01724

01591 **Wermund, E. G.; Jenkins, W. A., Jr.** Late Pennsylvanian shelf in north-central Texas [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 749, 1969.

Wermund, E. G. *See* Brooks, James E. 01707

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01592 **White, W. Arthur; Odom, I. Edgar.** Use of radiography in studying textural and structural properties of ancient argillaceous sediments which aid in interpretation of ancient environments [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 750, 1969.

White, William B. *See* Keester, Kenneth L. 07423

01932 **Wier, Donald Raymond.** Solubility of hydroxylapatite and some phosphate rocks [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3159B-3160B, 1969.

01840 **Wiggins, Virgil D.** Two Lower Cretaceous dinoflagellate species from Alaska: Micropaleontology, v. 15, no. 2, p. 145-150, illus., 1969.

The fossil dinoflagellate genus *Omatia* Cookson and Eisenack, 1958, is emended, and one new species, *Omatia butticula*, is described. The species *Omatia pisciformis* is

removed from the genus *Omatia* and placed in the new genus *Herendeenia*. These two species were recovered from the Lower Cretaceous Herendeen Limestone and equivalent strata on the Alaska peninsula.—Author's abstract

01902 **Wigley, Perry Braswell, Jr.** Conodonts from rocks of Marmor and Ashby age (Middle Ordovician) in Russell and Scott Counties, Virginia [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2945B-2946B, 1969.

Wilcox, John T. *See* Stearns, Richard G. 07502

02035 **Williams, P. M.** The association of copper with dissolved organic matter in sea-water: Limnology and Oceanography, v. 14, no. 1, p. 156-158, table, 1969.

Filtered samples of seawater collected off the coast of southern California to depths of 500 m were analyzed for inorganic and organically associated copper, before and after irradiation with high-energy ultraviolet light (which destroys organic carbon by oxidation). Organic nitrogen and organic phosphorus were also determined. No direct relation between the organically associated copper and the other analysands was evident, although nearshore surface samples high in organic carbon were relatively high in inorganic copper. Results are compared with those of Slowey et al. (1967). The increase in reactive copper after irradiation may not indicate a molecular organocopper complex as such, but a copper colloid surrounded by an organic sheath from which copper is liberated after oxidation of the organic matter by irradiation.—VMJ

Williams, Thomas E. *See* Brooks, James E. 01707

01895 **Willis, David Edwin.** An investigation of seismic wave propagation in the eastern United States [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2948B, 1969.

Willis, J. P. *See* VonMichaelis, H. 01964

Willis, J. P. *See* VonMichaelis, H. 02021

01749 **Willoughby, Ralph H.** Report on the archaeocyathids from near Emerson, Georgia [abs.]: Georgia Acad. Sci. Bull., v. 27, no. 2, p. 94-95, 1969.

Wilmoth, Benton M. *See* Ward, Porter E. 07461

Wilson, Charles W., Jr. *See* Stearns, Richard G. 07502

Wilson, James Lee. *See* Ward, William C. 01589

01961 **Winter, T. C.; Bidwell, L. E.; Maclay, R. W.** Water resources of the Otter Tail River watershed, west-central Minnesota: U.S. Geol. Survey Hydrol. Inv. Atlas HA-296, 4 sheets, scale 1:250,000, text, 1969.

Sheet 1 includes a map showing physiographic areas, a summary of water resources, and information on water use and water yield; sheet 2 pertains to surface water; sheet 3 on ground water includes a geohydrologic map, block diagrams, preliminary evaluation for development, and a summary of water quality; sheet 4 refers to water recreation. Large amounts of water are available from sand and gravel deposits along the Otter Tail River; yields of more than 1,000 gpm may be developed in some places. At most locations, water has low sodium and medium salinity hazards, and generally is very hard.—MCM

01759 **Wise, Donald U.** Regional and sub-continental sized fracture systems detectable by topographic shadow techniques, *in* Research in tectonics: Canada Geol. Survey Paper 68-52, p. 175-198, illus., table; discussion, p. 198-199, 1969.

Radar imagery of real topography or photos of side illuminated raised plastic relief maps enhance many elements of linear topography, particularly those valleys with strikes at acute angles to the light source. Complex fracture networks occur with

consistent orientation over vast areas of North America, some elements being correlatable with known fault or fracture systems. The systems extend without change to the edges of continents; they are independent of local curvatures and geometry of the mountain systems in which they occur; they continue from the Appalachian region into the youthful Coastal Plain. The relations suggest tectonic heredity of older systems being propagated upwards through youthful covering sediments and/or near modern stress trajectories of constant orientation. Traditional methods of analysis may be too small or limited.—*from* Author's abstract

07439 **Wohletz, L. R.** Interpretive soil maps for land-use planning [with French and German summ.], *in* Internat. Cong. Soil Sci., 9th, Adelaide, Australia, 1968, Trans., V. 4: New York, American Elsevier Publishing Co., p. 225-233, illus., 1968.

Rapidly expanding population around metropolitan areas of the United States is causing land-use problems. Public awareness of the threat to future agriculture is resulting in some state legislation, such as the California Land Conservation Act of 1965, providing for agricultural preserves wherein land is taxed on the basis of its agricultural potential. There must be active participation of people in community planning in harmony with the resource base. Interpretative soil maps are being used to show alternative uses of land; based on profile characteristics to a depth of 5 to 6 feet, they do not replace the need for on-site investigation and testing for specific structures. Colored soil maps, photographs and charts, along with other resource maps stimulate officials to become more active in broad resource planning and development.—*from* Author's summary

Wood, S. O., Jr. *See* Hawkins, M. E. 07448

Wright, Ramil. *See* Bandy, Orville L. 01694

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01896 **Wyder, John Ernest.** Geophysical and geological study of surficial deposits near Frobisher, Saskatchewan [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2948B, 1969.

Wyllie, P. J. *See* Lambert, I. B. 01719

Wyss, M. *See* Scholz, C. H. 01736

01937 **Yanizeski, George Michael.** Phenomenological characteristics of the laminar flow of neutrally buoyant particles in a rectangular channel of high aspect ratio [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 9, p. 3326B-3327B, 1969.

Yardley, E. D. *See* Axon, H. J. 07466

01897 **Yates, Michael Timothy.** Elastic anisotropy in rocks from the Stillwater igneous complex, Montana, and the Tinaquillo Peridotite, Venezuela [abs.]: Dissert. Abs., Sec. B, Sci. and Eng., v. 29, no. 8, p. 2948B-2949B, 1969.

01577 **Yedlosky, Robert J.; McNeal, James E.** Geological-engineering study of Cato (San Andres, Permian) field, Chaves County, New Mexico [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 751, 1969.

York, D. *See* Purdy, J. W. 07478

02003 **York, Derek.** Least squares fitting of a straight line with correlated errors: Earth and Planetary Sci. Letters, v. 5, no. 5, p. 320-324, illus., 1969.

Earlier least squares treatments of the fitting of a straight line when both variables are subject to errors are generalized to allow for correlation of the x and y errors. The method is illustrated by reference to lead isochron fitting.—Author's abstract

07394 **Ziegler, Alfred M.; Cocks, L. Robin M.; Bambach, Richard K.** The composition and structure of Lower Silurian marine communities: Lethaia, v. 1, no. 1, p. 1-27, illus., tables, 1968.

Five benthonic communities occupied shelf regions of the British Isles, Norway, and North America in Upper Llandovery times. Named after dominant brachiopods, they are listed in order of increasing distance from shore: *Lingula*, the least diverse community but including a substantial infauna largely absent in the others; *Eocoelia*, more diverse and dominated by epifaunal forms; *Pentamerus; Costistricklandis; Clorinda*, the most diverse. The main attachment surfaces for the small epifaunal brachiopods were disarticulated, convex-upward shells; in the three last-mentioned communities they were also attached to large brachiopods that lived free on the bottom. The communities, here reconstructed from five typical collections from Wales, are virtually identical on both sides of the Atlantic, forming a single zoogeographic province.—VMJ

07348 **Zietz, Isidore; Taylor, Patrick T.; Dennis, Leonard S.** Geologic implications of aeromagnetic data for the eastern continental margin of the United States [abs.], *in* National symposium on ocean sciences and engineering of the Atlantic Shelf, Philadelphia, 1968, Trans.: Washington, D.C., Marine Technology Soc., p. 283, 1968.

Zigic-Toshich, Darinka. *See* Briggs, Louis I. 07441

01581 **Zimmerman, James B.; Long, Laddie F.** Deep gas trend in west Texas—Geology and reserves [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 3, p. 751, 1969.

01730 **Zukas, E. G.** Metallurgical results from shock-loaded iron alloys applied to a meteorite: Jour. Geophys. Research, v. 74, no. 8, p. 1993-2001, illus., 1969.

On the basis of a study of a meteorite fragment from Meteor Crater and results of shock-loading experiments on iron-nickel alloys, it is concluded that (1) the impact-induced pressure in the meteorite was between 750 and 1,100 kb, probably about 900 kb; (2) the impact velocity was about 8 mm per sec (5 miles per sec); (3) the entire meteorite was not the core of another single planet; and (4) the meteorite consisted of at least three separate meteorites combined mechanically (not welded or alloyed) by collisions in outer space. The three different exposure ages found by Heymann (1966) are probably the actual exposure ages of these three separate meteorites.—DBV

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